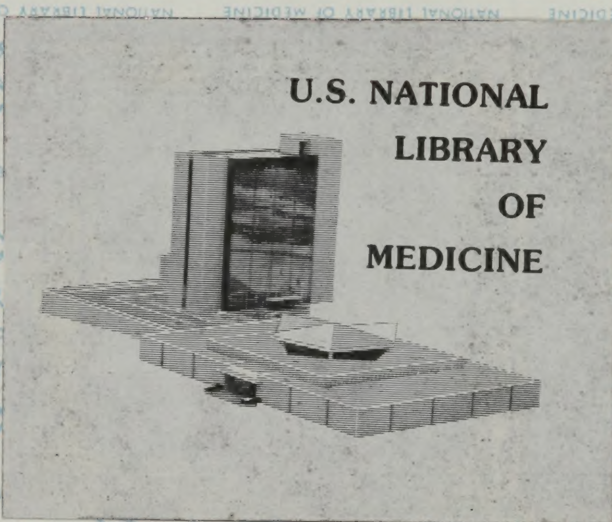
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POST-MORTEM EXAMINATIONS

BY

WILLIAM S. WADSWORTH, M.D.

CORONER'S PHYSICIAN OF PHILADELPHIA

WITH 304 ORIGINAL ILLUSTRATIONS

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TO

EDWARD L. MARK

PROFESSOR OF COMPARATIVE ANATOMY IN HARVARD UNIVERSITY

who opened to me the wonders of the Animal Kingdom and trained my mind in accurate methods of observation and thinking in biology;

EDWARD T. REICHERT

PROFESSOR OF PHYSIOLOGY AT THE UNIVERSITY OF PENNSYLVANIA

whose insight into the principles of Physiology helped me through many difficulties, and who encouraged me by example and advice and sympathy to strive yet more earnestly to understand the great problems of human life;

and to the memory

of

WILLIAM B. GRAVES

PROFESSOR OF THE NATURAL SCIENCES AT PHILLIPS ACADEMY, ANDOVER

who guided my first steps in the systematic study of the Natural Sciences.

PREFACE

Only those who have faced the difficulties presented by actual work in making and interpreting postmortems realize anything of the physical and mental labor involved—the mental equipment, including as it does every branch of medical science; the technic, demanding all possible skill; and the interpretations, requiring sound common sense and highly trained reasoning powers.

Where so much is to be done, and so many deep problems are continually presented, one is very glad of all available assistance, and is tempted to be impatient, in turning to the literature, to find so little help. During the sixteen years that I have devoted to the constant study of the human body I have been often compelled to revise the conceptions that appear in book after book with surprisingly familiar phrases. The problems of human life certainly have not been fully solved, and the methods of approaching them at the postmortem are no less certainly in need of vast improvement. The whole art has become a matter of routine, and has lost so much of its value that it is in great danger from dry rot. What should be a great and intensely interesting and profitable study has become in many minds simply a means of procuring material which is to be used in some minor investigation.

With the passing of the novelty of certain newer types of investigation of minor value we will more easily return to the larger interpretative work.

There is already a very distinctly perceptible awakening to the limitation of these minor subjects, and a tendency to return to the study of the human being as the harmonized whole, in which the various parts, tissues, and tendencies work together.

To meet this return to a broader reasonableness, and to supply from long and arduous experience some help to those who earnestly wish to enlarge their grasp of the problems presenting themselves, I have brought together some of the results of observation, thinking, and reading associated with the study of more than four thousand postmortems.

The manner of presentation will be found to differ very largely from that employed in other works.

Some of the material is new, much has been restated in a new way, and not a little will, of necessity, be a repetition of what has often been said before.

Throughout the work I have tried to encourage by varied comment, by definition, and by description the broadest possible view of

the human body as it actually is, with all its marvelous complexity, and to so far as possible point out right methods of taking this greatest of all mechanisms apart.

Much must be left unsaid because of the very marked limitations of our knowledge. More might be said, if space permitted, that would be interesting.

My problem has been to present matters not adequately discussed, or about which errors are commonly accepted, in such a way as to supplement the knowledge supposed to be the common property of all well-educated medical men. To do this with any continuity, and with any prospect of the results being of practical value, it has been necessary to trespass somewhat on other sciences, so that each discussion shall have, as far as possible, a measure of completeness. To those who have the persistence to carefully study what is presented it will, I trust, be apparent that the work is an essay on human engineering; that the conceptions of purpose, use, and dynamics have had quite as much consideration as mere form and structure.

That this self-developing, self-sustaining, self-regulating engine is a vast biologic unity of interlocking parts, and that mere dissection to get at the unilluminated and unilluminating anatomy, whether normal or pathologic, is only a minor part of human engineering. It will be seen that I give pathology the subordinate place which it must occupy if we see things as they are, and not through the eyes of pedantry.

Being somewhat in advance of the common level of postmortem thinking and practice will, I am sure, not seriously injure the usefulness of the book to all real students. I have not thought it necessary, in view of the variety and extent of my experience, to avoid the appearance of speaking with authority on my subject.

The photographs from which the illustrations have been made were taken with no small amount of labor specially to show the points discussed in the text.

The great consideration and wisdom of the publishers have done much to render the difficult labor of preparation easy and pleasant, and to them I wish to express my appreciation.

William S. Wadsworth.

Philadelphia, Pa.,
November, 1915.

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POSTMORTEM EXAMINATIONS

PART I

INTRODUCTION

When medical men had fewer matters to consider and the content of the sciences was less, more time was given to minor things, among which were terms and words. Perhaps there is no better way of clearing our thinking than by sharply analyzing our words, so that these minor matters still have their value.

I have selected the term "postmortem" for rather definite reasons, in spite of the fact that others prefer other words, and I must confess some of these sound quite as well. "Autopsy," surely the easiest word to speak, has rather too suggestive a meaning—that of seeing one's self. We have seen postmortems where it truly described what occurred.

"Ptomatopsia," "necroscopy," and "necropsy" all lay too much stress on the seeing, as if that were all that should be done. Perhaps they represent truly the mistaken attitude of some practitioners. "Obduction" is altogether too suggestive of what unfortunately one often finds in medicolegal examinations (the tendency to pull over).

"Section" is better applied to a definite limited process (*sectio cadaveris*), has but little more value, and *sectio* is simply an abbreviation equivalent to "post." I prefer to retain a term that has no signification of limitation.

The word "body" is much better than any pedantic substitute.

The term "cadaver," as do other old words, savors of the days when medical men had too little to think about, whereas now we have too much. It is, however, worth a moment's notice because of its suggested origin—not from *cadere* (to fall), but by contraction, after the old Latin custom, as "ca-da-ver," from *caro data vermibus*, or flesh given to worms.

It might be well if the public more frequently used this term with full realization of its supposed meaning; they would then find less horror in allowing respectfully made postmortems, for the worst could not compare with what must surely follow after burial.

The term "corpse" simply means body, though it is now applied almost exclusively to the dead body, but it has also accumulated a certain emotional value which renders it undesirable. The word "body" is the most suitable word because it gives less offense to the lay mind.

What constitutes a postmortem examination will depend very largely upon the circumstances and conditions of the particular case.

There is a tendency on the part of some to attempt to reduce this to a routine that may be regarded as some fixed procedure, and when the word "complete" is placed in front a phrase of almost magical significance presents itself. Many an ignorant lawyer joyously asks the witness if he made a complete postmortem, when the most that could be implied is that an arbitrary routine was followed. A postmortem examination may be extremely thorough—even to the most minute details regarding some few subjects—but a complete one is an utter impossibility, for the very simple reason that one sort of investigation destroys the material necessary for another sort.

No anatomist would attempt a complete dissection on a single body. How much less could one conduct all the different sorts of investigations that belong to the art of the postmortem operator.

We shall continue to hear this futile phrase, but we should do our utmost to discourage it. The question for us at all times is, What constitutes a *proper* examination under the circumstances?

The examination should vary in extent and in minuteness of detail, and in the selection of the things to be done and the relative amount of time, labor, and thought to be devoted to each.

It is as obviously absurd to treat the problems presented at postmortems by a single routine as it would be to insist on getting the square root whenever a mathematical problem was to be solved.

A clear case of pneumonia offers opportunities for study and presents problems entirely different from those of a railroad crush or a gunshot wound, a stillbirth, or a strangulation.

If one spends time and energy going through a sort of stage performance simply in order to be able to declaim about a complete postmortem having been performed, the chances are that the real problems of the case will have been neglected and the rational purpose of the examination defeated, or, at best, only indifferently accomplished.

The first thought should, therefore, be the *purpose* of the examination, and the plan to be followed should be adjusted to fit that purpose. There are a certain number of well-recognized purposes for which postmortems are made:

1. *To Determine the Cause of Death.*—This in a general way includes the others, but it is used in a more restricted sense to cover only those cases where the chief object of the examination is to give a satisfactory cause either for the family or for those who record death statistics, or as a preliminary step in medicolegal investigations.

2. *To Determine the Manner of Death.*—This question arises in cases where the cause is known or at least surmised, but certain conditions make it desirable to go further into the details.

3. *To Determine Contributing Factors.*—This constitutes a fuller investigation into the various questions raised by the death, and is of the utmost importance in all medicolegal cases. This is an unlimited investigation that opens up the vistas of health and disease to the fullest degree.

4. *To Continue the Clinical Study of the Case.*—Here the investigation will depend upon the history or clinical findings and upon the treatment. Symptomatology, therapeutics, physical diagnosis, as applied to the living, are extended, and signs and symptoms noted during life are compared with signs or findings found in the dead. All the skill of the diagnostician is to be brought to bear on the examination. The manner of proceeding will vary just as the examination of the living does in different cases. Too little attention has heretofore been given to this type of work.

5. *To Investigate Physical Problems.*—These include all effects of the physical forces on the organs and tissues of the body—heat, light, electricity, and violence of all sorts. We may know that death was due to one of these, and even the manner of death, but the investigation of what damage was done and how it was done and how it was limited or modified forms a very large group of difficult, interesting, and intensely practical problems to be solved.

6. *To Investigate Chemical Problems.*—Not simply such cases of poisoning as belong to legal medicine, but such as have to do with the whole range of pharmacology and therapeutics on one side and biochemistry on the other—chronic poisoning or internal or visceral secretions, qualitative anemias, bone variations—these and many other changes of composition that need attention.

7. *To Investigate Bacteriologic Conditions.*—As to the normal flora of the parts, to determine the growths after death, to recover forms that have caused or been associated with disease, and to note the changes produced in the body and its parts by such organisms.

8. *To Investigate Physiologic Problems.*—The comparison of the condition of the organs with already observed limitations or changes in function. These often are associated with anatomic and histologic studies, but are by no means to be restricted to such, for all methods which give us information as to the condition of the organs or tissues, both of the causative group and of the variously affected groups, give us a basis for true physiologic interpretations.

9. *To Investigate Pathologic Conditions.*—Not only to secure material to examine, but to enable us by all possible means to determine the quality and quantity of changes found in the parts and all possible information regarding causes and effects of such changes, with due regard to all coexisting changes. Too frequently postmortems are made with only a pathologic purpose, and that not always with any breadth of pathologic outlook. Too frequently the tissue collector is allowed to usurp the work that he is too small to perform.

10. *Anatomic investigations*, which are generally confined to the dissecting room, should more often be conducted during the routine work, and whenever opportunity offers, the many unsolved problems that may be called rational as distinguished from simple descriptive anatomy should be looked into thoughtfully. If this were done I am sure we would no longer tolerate what is now so common in the literature of anatomy; that is, gross errors regarding position, texture, and all the

physical properties of the organs and tissues. We would then have fewer plates of pickled specimens.

Perhaps we can construct another class of examinations—the medicolegal—though it will be simply a résumé of all the others, with an added point of view with regard to the conclusions. Each medicolegal investigation will be composed of a major problem with few or many minor ones. This is a very special sort of work that demands a far broader basis and more alert mind than any of the subdivisions mentioned.

Unfortunately, this class of work has fallen into disrepute, to an extent that cannot long remain uncorrected, by reason of the great willingness of entirely incompetent and untrained persons to assume the responsibilities, and the willingness of the public—both medical and lay—to not only permit, but to encourage, such a state of affairs.

It need hardly be pointed out that each object or purpose demands some change of plan to render any accomplishment possible. There is no escape from the need of good common sense and judgment in the adjusting of plans to the purpose or purposes for which the postmortem is to be made.

How to plan for a postmortem is gradually learned, and much that follows bears directly on this matter, but the beginner wants something rather definite to begin with; but all attempts to simplify the study of the human body have been failures and must always be such, because such simplification of what is naturally complex and difficult is a pretense at performing the impossible. It is perfectly evident that the attainment of an art that is worth mastering must be cultivated more or less gradually, and this presentation is certainly not a primer of the art of making postmortems.

No art should ever be approached without a definite understanding of the personal attitude that the practitioner is to maintain throughout his work.

This *personal attitude* of the operator is a most important matter. Seriousness in the work is the first essential. There is nothing that more quickly degrades a man than the careless desecration of the dead, not because of any special objective sacredness that attaches to what is left of the human body, but because it is a human body, and the disregard of that fact and its significance means that one forgets the great and vital truth that it is inhuman to be brutal to human remains. Vulgarity and brutality have no place in a postmortem room, and though we may be called on to perform extreme dismemberment of the body, we must not descend to the level of the wild beasts or of those pathophilic monsters who have made some foreign postmortem rooms a horror to civilized persons.

The *attention* of the operator not only must not be caused to wander by reason of outside disturbances, but it must be under control from within, so that it does not become relaxed by reason of a tendency to talk or to follow side issues.

Of the bad postmortems I have witnessed—and I have seen some

very bad ones—most have been bad because the operator had not learned to concentrate on his work in the beginning of his career.

The preparation for a case should include the careful planning to prevent disturbing influences of all sorts.

Now it should not be forgotten that overzealousness often defeats itself by straining the mechanism of the mind. Let the plan to avoid distractions in no way interfere with the recognition of the fact that close attention must be very frequently relieved, just as truly as muscular action is never most efficient if continued without relaxation at very frequent intervals. My own habit is to work quickly and intensely for limited periods of time. Then when I reach a point where I can relax hand and eye and brain from observing and cutting, I turn to the consideration of what has developed. So by alternating observation—cutting and thinking—I can attain my maximum efficiency. The beginner is too apt to grasp his knife as a drowning man does a rope, and before he knows it his skill has faded and his cuts are clumsily done.

The overtense mind shows similar changes, with the result that it no longer does decent work. Orderly rhythmic alternation of effort is the only natural way to attain efficiency. If this were better known we would be saved from much of the stupid work done by men who are naturally far from being dull, and the golden opportunity to interpret the wonders of the human body would yield fewer of the platitudes and inanities that come to us in the literature of postmortems. Of course, this does not apply to the naturally apathetic fellow who needs some driving to get started. He will relax quite often enough, and not infrequently he finds by pure accident the magic secret of alternating effort.

There are many faults that fix themselves on the operator who disregards self-criticism, and by far the worst is narrowness. The subject of our art is not to be regarded from a narrow viewpoint. Mere anatomic details or bacterial problems, or the gathering of tissues for microscopic study will never yield results in any way comparable to the opportunity.

One-sided work at the postmortem generally defeats even the tiny purpose of the toiler. To see a neuropathologist, interested only in his little phase, ignore the great factors of infection, of chemical condition, or of the influence of the other organs on his pet tissues is no uncommon experience, and one cannot help thinking how much better would be his grasp of his subject if he only spared a little time and energy to see things in a larger way. Every person who specializes is tempted to fall into this serious error.

The pathologist frequently sees only the defects, like a fussy housekeeper who sees only the dirt on the window-pane rather than what is beyond. While it is perfectly right and proper to specialize, one should never be deceived into thinking that hunting for pathologic specimens is making a postmortem.

What we see at a postmortem is neither anatomy nor pathology, but a wonderful mechanism that has stopped, and while we are looking for what is there we find what was normal, what was changed, and what

was pathologic, and usually the pathologic findings are only a small part of what we find. We find not simply organs as described by the morphologist, but we find signs in those organs which tell us of functions, and of the way those functions were performed, and we should have some very definite conceptions as to what those signs mean to the organs and to the whole body, and if we have these conceptions and they are correctly built up from all that was to be observed, we have a far better basis for our conclusions as to the lesions and the pathogenic factors underlying them than if we simply reached for the diseased parts and, having secured them, ran away to a laboratory, there to indulge in the practises of the histologist. In planning and in following a plan for a postmortem we ought to give the honest values to all the special ways of investigating the body, and not be mastered by any one of them.

The greatest errors result from carelessness in planning what is best to do at a postmortem. To follow a routine that might, if followed out by a thoughtless person, assure a good average result is to repudiate art and to drag science back to stupid barbarism.

The clinician who restricted himself to such a routine as is often advocated for the making of a postmortem would very soon earn his reward in the ridicule of all live practitioners, and would, by his stupid plodding, soon stultify himself. Thoroughness when combined with competence is never the slave of a system, but the master of all desirable plans.

I know of no better example of the futility of slavishly following a routine procedure than that given in Virchow's Second Protocol, where, after the examination lasting several hours and the report filling many paragraphs, one finds that the gunshot wound, which was the essential thing, has not been even tolerably described, either as to the size or direction of the wound, its condition in relation to the weapon, or its nature as a lesion, whereas an intelligent examination would have displayed the conditions in a few minutes, and a single paragraph sufficed for its description.

It is vastly better to cultivate openmindedness and alertness, so that each problem is perceived before it is too late, and the investigation in general is adjusted so as to permit of the proper study of the evidence of some important condition.

Such readiness to turn aside for reason is a very different thing from mere irrelevant curiosity that follows unimportant leads and clues and disregards orderly procedures.

If a person has any uncertainty as to his ability to follow the large free way of planning and developing the plan as the examination proceeds, let him follow rather closely the general scheme laid down in subsequent chapters, but the desirable ambition should lead one to develop the ability to disregard routine and to formulate his plan in each case.

To formulate a good plan requires experience, to follow a routine requires practice. If a routine is learned as a task of memory, without explanation of its meaning, it does not form a good working basis.

The beginner who is to make an examination on a case had better devote his time and energy in studying up on what he is likely to find before the examination and what he did find after it is finished.

In all postmortem work it is desirable to cultivate as much speed as is consistent with proper care, accuracy, and due deliberation. There is so much to do and see and think about that the available time must not be wasted.

The most exasperating thing I have to endure is to stand by and observe an operator whittle when he should make a business-like cut, and dabble about as if not sure just what to do.

It is far better to spend five minutes thinking what to do and ten seconds doing it, than ten seconds thinking and five minutes in doing it wrong.

The habit of making every movement and every act count is invaluable because, when once formed, the drudgery of the work is enormously reduced. It must not be forgotten that a thorough investigation of a difficult case is very exhausting both on body and mind.

We expect that a fairly well-educated medical man will have considerable knowledge with which to begin. It is not uncommon for persons to overestimate their preparedness to understand and carry out a postmortem.

On the other hand, I find very many persons who have a genuine high-grade modesty. Sometimes this modesty depresses them so that they do not use the very considerable knowledge they have. It is not possible to have too much knowledge of any of the sciences underlying medicine, but it is not only possible but a rather common occurrence to have gained much knowledge in a limited field at the expense of other topics as valuable, if not more fundamental. There is a tendency today to leave the ninety-and-nine tame subjects and go after the one that is distant and exciting.

One should have a good working knowledge of *anatomy*—a thinking knowledge, not a parrot-like memory of the names and descriptions. It is unfortunate that descriptive anatomy must of necessity deal with the average condition and furnishes very little of the scheme on which variations may be expected, or of the general harmony of such variations. At the postmortem we have to interpret just these departures from the average, and to determine whether they are normal for the case or whether they indicate abnormality.

It is also unfortunate that much of the available anatomy is obtained from preserved bodies and pickled specimens, and that many of the plates are diagrammatic, and often the artist has been allowed too great freedom, departing from the limits of strict accuracy.

At times one is sorely tried by these "artistic" departures, as in the case of the circulation of the brain. I have introduced a few photographs on purpose of parts where the ordinary text-books are strikingly at fault, because so much depends upon the correctness of our estimates of the normal in making interpretations at the postmortem.

Fundamental as is the subject of anatomy, the understanding of findings depends even more on a knowledge of *physiology*.

The archaic terminology of anatomy is a constant annoyance to the thinking person, and I consider it eminently desirable for the progress of the art of making postmortems to avoid so far as is possible the use of anatomic terms. This attitude I realize is rather radical, even to the younger generation, and may seem very dreadful to those of the older days, but it is distinctly in the line of modern progress. If we could arrive at a point where anatomy was really the handmaiden of physiology and less of an object in itself, we would make greater progress in right thinking about the human body, and that I conceive to be the object of the first part of medicine on which the remainder must rest.

It is essential for us to cultivate most industriously and thoroughly our understanding of how the parts of the body perform their functions. Of course, that implies a knowledge of what those functions are and what the parts are. I cannot conceive it possible for a person to know too much physiology, though I have not rarely seen false values given to partial knowledge.

It is better to have a good broad working knowledge of all the field than to have a very intensive familiarity with a few special topics.

To know all about the gastrocnemius of the frog is very desirable, but to find such topics exclusively taught and such tremendously important matters as muscle cramp hardly mentioned is far from satisfactory.

What we need is an understanding of clinical physiology, where every vital phenomenon is rightly interpreted and the concomitant anatomic changes noted. Where the available information is insufficient, and the places are unfortunately many, we must build up as best we may a sort of postmortem physiology.

The postmortem offers a wonderful opportunity to observe arrested physiologic processes, and to so study the remaining signs, substances, and conditions as to give remarkably valuable assistance in physiologic problems.

In the matter of *physics* we are constantly taxing our knowledge. Not the mathematic sort of physics that is necessary for advanced mechanical engineering, but the sort that deals with principles, with the manner of action of force under all the conditions that are found in the body.

With modern physical measurements we have little to do, but with every mechanical principle and with heat, light, electricity, and the properties of matter we are, or should be, always busy.

One is often surprised to hear or read discussions about bodily conditions that show a most decided lack of comprehension of the fundamental physical principles involved in the problem under consideration.

Physics as applied to the body has not of late received the amount of attention that is absolutely necessary for the solution of the problems we find.

Organic chemistry has become such an enormously complicated sub-

ject that the master minds who are alone competent to give us a résumé of the field are so engrossed in some special topic that it is difficult to obtain the information we need to enable us to begin to understand what we see at the postmortem.

As a result we find far too frequently a tendency to avoid all chemical discussion, but what is worse—yes, actually culpable—is the tendency to seek for some non-chemical explanation for a chemical phenomenon. The almost maniacal insistence with which some pathologists seek to explain chemical problems by some bacterial theory is a painfully common phenomenon.

While we urge the utmost care and diligence in the study of chemical problems by means of the most advanced chemical knowledge, we must add the caution that the limits of chemistry are to be remembered, for just as the chemistry of the pigments of a great painting fail to express the value of the painting, so the utmost that organic chemistry can do will not approach the marvelous and complex structure of the human body.

There is absolute need of a science of what lies beyond. There is such a science, and to all biologic problems we must bring a knowledge of *biology* if we are to attain true results. For the average medical man there is no more accessible approach to the biologic principles than *embryology*, because it leads from subjects with which he is somewhat familiar.

If the student has not had the benefits of a biologic training, I know of no simpler or easier way of gaining an insight into the principles of the origin of tissues and their evolution under impelling forces, and of how from tissues apparently homogeneous arise quite different structures, and how such formative forces are modified by conditions.

If a man thoroughly understands embryology I would trust him to draw conclusions regarding pathogenesis. If he does not, he will accept many of the vague and preposterous bacteriologic accounts that are rather prevalent. Without a knowledge of the principles of biology it is difficult, if not impossible, to gain any adequate grasp of the things that have gone on in a human body by which it has arrived at the condition in which we find it at the postmortem. In order to understand the findings in the organs we must know what has been happening in the body. Not simply in the part immediately under consideration, but in all parts that directly adjoin and those that indirectly influence the particular structure.

Too often we are tempted to ignore the part played by the nervous system. In a way this is but a part of physiology, and yet in the human being in the phenomena associated with the activity of the nervous system we find a sort of superphysiologic something which has been called psychologic, and it would be well if we could be more scientific in our postmortem work and include all the factors that exist, and not so readily ignore this or that group, either because of ignorance of its meaning or from prejudice, or from being too busy about a part to have time to consider the whole.

The fact that death itself belongs to this often neglected group of phenomena—that a very considerable portion of the human race is confined and kept under restraint because of some functional disturbance of the central nervous system, and that pathologic findings do not alone explain the clinical history—should at least seem to encourage the broader point of view in relation to the significance of psychology. If we but realized what it was that we operated on we would be impelled to turn to the brain and nervous system with more profound interest.

It may seem strange to some that I have said so much about the normal and about the sciences that study the normal, whereas it is a common habit to regard the making of postmortems as a sort of minor branch of pathology. It is hardly possible to account for the present degraded condition of the art of making postmortems than by attributing it to this very habit. No other fate could be expected where a great study that should include many arts and sciences is held in check and dominated by one of the minor sciences that should be subservient to it.

It never will be proper to regard the study of the human body, either in life or in death, as a branch of pathology.

It is easy to see how the present conditions came about, and it may and probably will continue to be desirable for pathologists to make postmortems, but they should regard this work as their golden opportunity to keep in touch with the great body of the medical sciences, and to attain a broader view which will vitalize their specialty.

Seldom do we find a body where the amount of normal tissue is not far in excess of the abnormal. Never do we find a body where everything is completely pathologic.

Our problem, as a whole, is to estimate the general condition of the body, and to determine what the normal of that body was and what departures there are from the normal. It is clearly necessary to have an understanding of what is normal and what is abnormal. For the one we have the already mentioned sciences, and for the other we have pathology.

Our knowledge of pathology must never stop at the simple descriptive stage, but must extend to a realization of the nature and extent, the quality and the quantity, not only of the abnormal part, but of the causes and effects which caused such a departure to be produced when the original impulse of the organism was, supposedly at least, to produce only the normal.

To simply hunt for pathologic findings is to debase the art and waste the opportunity for far greater things. To be able to recognize various pathologic lesions is as necessary as to recognize the organs, and both pathology and anatomy are legitimate sciences in themselves, but to turn the making of postmortems into a subdivision of either is palpably wrong.

A misconception far too frequently met with is that one can gain a knowledge of the normal from the study of the abnormal alone. This is seen when alienists begin by studying the diseased mind, and seldom come to know the normal. They carry always with them a sort of pathologic incubus from which they do not escape.

What we find at the postmortem must be considered as a whole, and of that only a portion will be truly pathologic. It is for us to diagnose the case, and we find *postmortem diagnosis* is but a continuation of clinical diagnosis in which certain factors have disappeared and certain new phases and methods are to be added. While symptomatology is no longer possible, the records or *clinical history* of each case should be studied as carefully as possible, so that there shall be a continuity of observation beginning before death and ending only with the last study of the body. Whatever would be important in clinical diagnosis in the living, should it remain after death, has just as much value then.

Every sign of the condition of the body, either of nutrition, of health, of disease, or of any factor in life or death, should be given its true value, and the postmortem examination is more likely to furnish the data for such interpretation than is the examination during life, because the organs are more accessible.

It is always necessary to remember what changes occur at or after death, to modify such signs, and also to change the concomitant variations associated with them.

No clinical diagnostician would think of ignoring the condition of healthy organs as part of his work, nor can any such practice be tolerable in the postmortem diagnostician.

The *clinical history* of every case should be sought for or demanded before beginning a postmortem. This is not commonly the custom, but it should be, because it often materially helps one to formulate the proper plan of procedure, when otherwise one would have to pursue a routine, which is always the inferior way.

If a man dies in coma and the operator does not find brain or kidney lesions, he is apt to be very much at sea in his work.

Very often I am called to cut cases where a diagnosis of poison has been made. Often I find the symptoms have been fairly well observed, but the deductions are at fault. In such cases the observations are often of the greatest value.

At other times there is a conflict in the data collected which shows an error has been made, but even in such cases the data is generally a help.

To cut a case that has been treated, without a clear knowledge of that treatment, is to open one's self to a host of mistakes. Even if the observations are all bad, the treatment sheet is of vital importance.

The administration of drugs rests on the perfectly patent fact that they produce changes in the body. What those changes are may be imperfectly known, but how can they be better studied than at the postmortem, where the affected organs are brought to direct inspection? The condition of enteritis which follows a purge, if discovered and described at the postmortem, must be attributed to its true cause or to some other cause. If we have learned to know that a certain picture in the gut means that a purge has been given, we can do without the history, but how are we to gain such information unless we begin by calling for the treatment sheet in a number of cases?

Therapeutics we must know or we will mis-observe many things

at the postmortem, attributing findings to wrong causes more or less constantly. This I have seen done very often at examinations conducted for the instruction of students by masters of pathology because they ignored the therapeutics of the case. I could quote from hundreds of protocols where the conditions have been associated with the pathologic findings when they were simply the result of the physiologic action of drugs. Therapeutists have much to learn at the postmortem, and the operator must bring himself to realize that while much is still unknown about the postmortem pictures produced by drugs, much can be learned which it is vital for him to know for right thinking about what he sees.

When postmortem operators and the rest of the medical profession come to really understand what a postmortem can be and should be, there will be little trouble in securing a better spirit of coöperation than is usual at present. The clinician not infrequently hesitates to admit that the drugs he has given have any part in the picture. No more grave error could be made, for he thereby loses a golden opportunity to enlarge his knowledge of therapeutics and diagnosis, and develops an unscientific lack of frankness that degrades his own mind.

This brings up the *ethics* of postmortems. Truly this is a dangerous topic, for those who talk loudest about ethics are apt to substitute rules for principle. To start with the *Golden Rule* is generally safe and sufficient, but at times suggestions of details are helpful.

Morally, the work belongs to the man who does it, whether it be clinical or pathologic, before or after death. In private cases the physician who had the case has wider authority and should determine the disposition to be made of the data, but this does not excuse the clinical hog, who is by no means as rare as he should be.

The rights of the dead and of the family should be considered. The rights of the operator to the fruits of his labor and skill should be protected and respected, but his debt to his profession should lead him to all possible liberality. My rather varied experience has taught me to be on my guard in all cases, for well-meaning persons are often thoughtless, and very reputable persons are not always scrupulous.

It is unfortunate that medical men come from the mass of the people rather than from some specially angelic tribe, for they bring with them all the characteristics of the outer world, and are, therefore, not always to be trusted. It is necessary, therefore, while striving to be honorable, accurate, and considerate, to be also discrete, not only in the matter of looking out for one's rights, but in giving away important personal knowledge. This matter is really important in all medicolegal work, for it is astonishing how one's words can be mistaken when heard by interested parties.

The amount of talking to be done will vary from the teacher who tells all his pupils ought to know to the medicolegal expert who says nothing, or the matter may be in the nature of a consultation, where the operator was selected because he could and would interpret rightly what was found for the benefit of those present. It is always dangerous to talk over the heads of a group, and no less dangerous to chatter thoughtlessly.

PRELIMINARIES

No postmortem should be arranged for unless proper authority has been secured.

While there is little statute law regarding the rights of family or friends to a dead body, there is a very considerable number of rulings in the body of the common law. It has even been held that the family may prevent a body being dissected though willed or given during the deceased's life.

Certain postmortem examinations may, however, be legally ordered without regard to any rights or feelings on the part of the relatives or friends. Coroners, medical examiners, and, at times, certain other officers of state or county may order such examinations as part of their official duty.

Courts of law have, on presentation of sufficient reason, allowed such examinations. In certain states laws have been passed directing unclaimed bodies to be delivered to certain authorized persons for anatomic purposes.

In all other cases permission should be obtained from the relatives or persons claiming the body for burial. Where several claim the possession of the body, the matter should be settled according to law before incurring the risk of an unpleasant suit for damages. Usually there is little difficulty in determining who is "next of kin," and such have the right of disposal.

Permission or Authority.—It is well to be cautious in these matters, for not a few unpleasant complications have arisen regarding unauthorized or improperly authorized postmortems.

It is well to have and retain evidence that permission was given. This is usually accomplished by having written authorization. Witnesses to the granting of permission may answer the same purpose.

Where the next of kin is absent and cannot be reached, and their attitude cannot be known, it is well to be sure that those acting for them have sufficient right to give permission, and that they will avail as protection if the next of kin becomes irate or vicious in the matter after the postmortem has been made.

The matter of procuring permission should be undertaken with gentleness and consideration, but with a clear grasp of the reasons why the postmortem is desired and should be granted. The manner of asking or reasoning is so largely a matter of tact that hardly any suggestions will be of general usefulness.

Certain hospitals require the patients and the persons responsible for them to sign a joint authorization for a postmortem examination in case of death, which, I believe, is the most satisfactory way from the operator's point of view, but few hospitals are in a position to enforce such a contract rigidly.

All hospitals conducted at the public expense where treatment is free should have the right conferred by statute law to hold proper postmortems on those who die. Such regulations should be coupled with equally strict ones preventing any debasing brutality which might result. For, while respect for the sciences and arts of medicine should modify sentiment and prejudice on the part of the public, experience has shown that without suitable supervision some medical men show a disregard for the feelings of the living for their dead which more than anything else keeps alive popular prejudice against any progress in the matter of routine postmortem work; aside from this, the medical profession can ill afford to encourage or allow any descent into barbarism: first, because of the malign influence on the profession from within, and, second, because of its bad effect on the public which it is striving to serve and educate. It is bad practice to do wrong and try to excuse it by telling of the good medicine does. It is, therefore, not simply a short-sighted policy for the medical profession to allow any group of reckless, thoughtless, or crudely brutal individuals to abuse the bodies of the dead, but it is a direct wrong done to that profession to allow unbridled freedom to any brutalizing practices in the matter of postmortems as well as in experiments on the living or on animals.

Permission having been obtained, certain preliminaries should be arranged.

The **time** to perform a postmortem will depend on a number of circumstances. In certain countries the body must not be opened, except under special circumstances, before a certain number of hours have elapsed since death occurred; this is better than reckless haste, but is certainly not the best method, for it was laid down before the development of modern sciences, especially bacteriology, and it is better to make examinations at the earliest possible time.

The assurance that the body is really dead must, of course, be had by the most careful examination. The time will often depend upon the convenience of those who are to be present at the examination, and it is often necessary to postpone or advance the time to accommodate such persons. The matter of light is less important than it was before modern artificial illumination had reached such a satisfactory stage of development. If death has occurred before noon it is often better to perform the examination the same day. If death occurred after noon it is better to postpone it until the following day. Night examinations should, as a rule, be avoided unless the circumstances are unusually urgent or the conditions unusually favorable for the work. When the body is to be kept for any time before the examination, care must be taken to be sure that it will be properly kept.

The **preservation of the body** during this time must be looked after by some one who can be relied on. Generally an undertaker of experience will understand the necessary proceedings and can be left in charge, but one often finds such confidence misplaced. In cold weather the body may be left in a cold room, with the heat turned off and the windows slightly opened and with only the lightest covering on.

In warm weather some form of refrigeration is necessary after a few hours. Putting ice directly on the body is only to be allowed in extreme cases of decomposition, or where it is known that the internal heat of the body is unusual and will cause rapid change. In hospitals suitable refrigerators are usually found in the mortuary, and the air chambers are cooled artificially. When these are lacking, or when the body is to be kept in a private house, the wooden box with suspended ice pans is the only alternative. Much has been written about other methods, but they may be disregarded. The use of preservatives in any form should only be tolerated in cases of extreme decomposition.

The **place** has perhaps been too much considered, yet it is perfectly obvious that we should select the best possible place under the circumstances.

Having made examinations in so many sorts of places and under very varied conditions, I am fully aware of the value of proper surroundings, but am not overwhelmed by any difficulties. I always get the best possible light, and if possible I secure room and ventilation, but freedom from disturbance, interruption, and annoyance is most essential. I have made examinations under strange conditions, but this is most exhausting, because the already considerable strain of a difficult postmortem is enough without having the noise of a howling mob of excited foreigners in one's ears or the imminent risk of being carved by a party of drunken attendants at a wake, or being peeped at by the populace, or any of the thousand other annoyances incident to house-to-house work.

The temperature of the place is a matter that should, if possible, be regulated. Where this is impossible, extra underclothing must be arranged for. I wear a loose cravenette overcoat with easily rolled sleeves always in winter, and in cutting in the open air, at cemeteries, or in vacant houses I suffer but little because I have extra heavy woolen protection underneath.

All postmortems cannot be made in good public, private, or hospital morgues.

Certain simple **conveniences** beyond the kit one carries in the operating bag are needed. In the ordinary house one can obtain towels and soap at least good enough to clean up the instruments, gloves, and the body, the liquid soap and the towel in the kit being used in emergencies. A few newspapers will be needed in head cases or where the body is already in the coffin. An old sheet which can be torn is always desirable. A basin or bucket of water which is not too cold is sufficient for an ordinary examination, but where there is internal hemorrhage or much fluid an extra bucket is needed. I have made hundreds of examinations on bodies on beds, scores on the floor, a few on the ground, and many hundreds on cooling boards or in ice-boxes, but only to examine children have I used the house table. The mistake is generally made of having the body too high for freedom of arm movement, and, while it is a bit hard on the back to work when the body is too low, the results are better when it is low rather than high. If one's technic is so bad that one cannot prevent messing

the surroundings, then it will be necessary to have extensive preparations to save carpets, furniture, and wall-paper, but such sloppy work, while common enough, is not excusable after the first few postmortems except in very difficult cases.

I have had mishaps in cases of intestinal perforation, advanced decomposition, extensive internal hemorrhage, but in my routine work the usual towel and soap and basin of water, with bucket, newspapers, and old rags, suffices for even the unusual examination extending over several hours of rapid work, and, aside from the odor, one would not know a postmortem had been performed. I shall later on take up the comfortable postmortem room and its fittings which are entirely proper and desirable, for it should not be inferred from the fact that satisfactory postmortems can be made under difficulties, that it is desirable or proper to make them under such conditions if it is possible to avoid it.

Who Shall Be Present at the Postmortem.—If the operator is simply doing the work for others, the physicians in charge of the case will determine this among themselves, with regard to the wishes of the family.

If the operator sees that there is likely to be a difference of opinion among those present, or that one or more are likely to misbehave, either through lack of knowledge of the decorum for such occasions or other reason, he will do well to immediately call together those who are to attend and clearly and definitely settle the plan of proceedings—gently but firmly taking charge. By asking each person what he wishes to have shown, and forming your plan, as far as possible, so as to show each what he wants to see, you may avoid confusion.

One man should be in charge of the examination at a time—a sort of presiding officer—who may relinquish it temporarily for some reason. Nothing is more intolerable than to have some cub pulling at the parts at the wrong time when you are at work.

Allow each person present to see what you see, and stop frequently and ask if any one wishes to see further into what has been done.

Simply ignore or gently quiet irrelevance as far as possible.

It is better to be too quiet than too demonstrative even in cases of no importance; in serious cases this is imperative. I have found it generally desirable to limit the number present, and whenever a small number is exceeded it becomes necessary to assume authority in order to have the affair conducted properly, even when those present are thoughtful. I always discourage members of the family or close friends from being present, and all lay persons must have special reasons for being allowed to remain.

In hospitals the clinical chief should treat the operator as he *should* treat a colleague in that colleague's ward, and the operator should have command unless he is simply working for his chief who is present.

The postmortem room should be a place of keen observation, careful thinking on acquired knowledge and right conclusions, and bluff and all manner of dishonesty should be rigidly excluded. Students should be made to feel these things by the general atmosphere and method of the place. They should be shown the right way to do the work, and then their attention called to the principles involved as well as the details.

DEATH AND THE CHANGES IN THE DEAD BODY

(THANATOLOGY)

As I think how my conception of what death is grew from the earliest childhood experience, through the student days when I watched the action of heat and cold, electricity, drugs, physiologic and pathologic conditions producing cessation of vital activities from the lowest living form upward, and saw elements added to the complex problem, I do not wonder that the hasty philosophizers who lack any part of these observations have given out curiously unsatisfactory expressions regarding death. A common definition is that it is the cessation of all bodily functions, but it is common knowledge that certain of the bodily functions continue after death. A man with his head cut off is surely dead, at least after a few moments, but the viscera and muscles are alive for hours.

A man in profound trance, such as is seen in Yogi sleep, is quantitatively more dead than a man with his head just cut off, for there is greater cessation of bodily function.

The law takes no account of the persistent life in the viscera and muscles and lower nerve paths and centers, but pronounces a man dead the instant his head is cut off, because it regards man as a psychic entity (a large term, meaning a living person), but we often see a patient psychically dead for a considerable time, or, as we say, in profound coma following the destruction of that part of the brain used by the person, but the law does not count him dead in such cases until his viscera appear to stop, thereby establishing at once two opposing standards of legal death. In medicine, where we usually find better thinking, we still find some confusion.

We find a man killed by shock or poison. His brain is permanently stopped, but his heart still beats, and we apply the pulmotor and his heart continues to beat and his muscles to react and his viscera to work. When do we say that he died? By common consent, when the heart stops, though the muscles still react and the man was just as truly dead an hour before. We do this not from a scientific point of view, but from a practical one. It may hastily be concluded that because these two viewpoints are opposed, and that we must come finally to the practical one in all matters of issuing certificates, that the scientific viewpoint concerns us but little. No greater mistake can be made by a person investigating the causes of death than ignoring a preliminary survey of death itself.

A common definition of death is the cessation of the vital functions. Before we came to know how many vital functions there were in the body this was very simple.

Another crudity which is still common is to suppose that death is simply a negative of life, and for years the part that the organs played in the harmony of the parts (which we call health) was conceived of as a doing or failing to do, and death would result if the part played was a vital one and the part was simply not done. We can, however, at the present time, with comparative safety, point out the danger of omitting the positive phase of death causation.

The other great mistake is to confuse the manner of death with the cause. Practically, this is often necessary in writing out a certificate, but it should not satisfy us. In the great majority of cases the terminal myocarditis is the cause of the stopping of the heart, but in not a few cases that I have seen this was the result of and not the cause of death. Suppose while a true postmortem myocarditis was developing the dying blood clotted and there was a pulmonary thrombosis, would that thrombosis be a cause of death?

Vital Organs.—We now recognize that the removal of certain organs will surely bring on death, that the removal or serious injury of some of these will bring on sudden death, and that other organs play so important a rôle in life that death generally follows their removal. This scale of vital organs is not yet fixed, but we already have a good beginning. We know that without the circulation life is sure to stop, and that quickly—seven minutes appears to be the limit. Respiration can in extremely rare cases be suspended, and these are only to be found when training or shock has previously caused inhibition of the other functions. As a rule, respiration cannot be suspended over seven minutes.

Sudden death from conditions of the kidney is very common.

Where an organ frequently gives rise to sudden death, we may class it in the major group of organs, and the manner of death or how it causes death may be regarded as a scientific refinement, to be ignored in rough, practical work, but not to be ignored when we really think. Therefore, we must consider how these groups of organs produce both the death of the individual and of the hordes of tissue cells.

It is hard to conceive of either life or death in man without the nervous system, and we are compelled to regard it as the center of both, and regard true human death as something different from that of a plant or of a pithed frog or of a decerebrized pigeon.

Those who have actually studied death in its various phases should have no difficulty in realizing this, because a change has come over the expiring (note the respiration implied in the word), and know, by the assurances of instincts deeper than science, that a positive something has happened that has received a separate word in every language. The nervous bottom of life has dropped out, and heart and lungs and viscera all sink into insignificance when compared with the nervous system as the place where death actually takes place, though they often take active enough part in causing it to take place. We pay altogether too little attention to the nervous system, possibly because it is difficult, possibly because it is unknown country in our insignificant anatomic and physiologic knowledge.

The fact of death is rarely a matter of doubt; probably an intelligent layman would not err once in a thousand cases, and an ordinary medical man not once in ten thousand, and an expert not once in a hundred thousand. But cases are on record of such errors, and human life has been lost as a result; not as often, however, as certain writers would have us believe. I doubt if one death in a million is mistaken, but no one cares to make that mistake. We, therefore, have to consider a practical refinement, finer than the scientific ones that we have touched upon, and take up briefly the signs of death. That such a discussion may be made profitable we will consider them under the phenomena of death.

PHENOMENA OF DEATH

Arrest of Circulation.—The surest proof of death is determined—

(*a*) By the absence of heart impulse, either locally or in the vessels.

(*b*) By failure of a cut artery to bleed, which is the best test.

(*c*) By changes of color, either pallor or suffusion, the former in heart stoppage and vascular spasm, the latter in asphyxia or general spasm or lividity.

(*d*) By coagulation of the blood; of use when found, but by no means a sure sign.

(*e*) By failure of the veins to fill, which is often given, but is a most misleading sign, as I have seen the veins fill readily after death by gravity or by pressure within the body cavities.

(*f*) By reactions to ammonia injected under the skin.

(*g*) By the effect of fluorescein injected into a vessel, giving color effects in different and distant parts.

(*h*) By the reaction to burning or blistering. These are not reliable because they will occur for a limited time after death and are in part tissue reactions not depending wholly on the circulation.

(*i*) By the *x*-ray examination of the heart itself; valuable, but rarely practical.

(*j*) By the transmitted light seen when the fingers are brought into contact and held in front of a strong light—pink in life, pale yellow in death—much relied on by some continental writers.

(*k*) By a mirror on the epigastrium or chest and a beam of light reflected to a distant surface, which will show any motion highly magnified. This is usually done to show respiratory movements, but gas movements in the gut, muscular action, or peristalsis might easily mislead a nervous observer.

Errors are likely to occur in nearly all of these tests, specially where the local circulation in the part tested is interfered with or the circulation is extremely feeble or highly inhibited.

Specially faulty are those depending on observations of the color; as cold, vasomotor conditions, and local circulatory disturbances may interfere. We now know that the heart may actually stop for a short period or beat very irregularly or at variable intervals. All these would invalidate certain tests unless prolonged or, better, confirmed by the other signs.

Arrest of Respiration.—Respiration is more variable than the circulation and can be readily suspended for several minutes, and in extreme cases for apparently indefinite periods, as in hibernation and Yogi trance.

Various forms of respiratory paralysis and arrest are found which can be overcome or tided over by artificial respiration. As a sign of death it is of little value in doubtful cases.

The ordinary tests are: (*a*) observation of respiratory motion of chest or diaphragm, direct or by a dish of water or mercury; (*b*) observation of the movement of air at mouth and nose by a feather or by the clouding of a cold mirror.

Changes of Temperature.—The body has a surprisingly narrow range of temperature during life, yet parts may be actually very hot or cold. The surface temperature is not to be relied on. During life the temperature very rarely rises to 110° F., but after death it is not uncommon, and at times it goes much higher, especially when heat production has been active just before death. A high temperature may continue for a very considerable time after death. Either by reason of the surroundings, warm place, blankets or other covering, or because of considerable fat or by the early onset of excessive postmortem changes, as is seen in certain severe infections, the body must then have been dead long enough to have cooled down from the greatest temperature reached to a point so low as to be incompatible with life. In case of doubt one would, therefore, never use this, because in case of doubt the body would be kept warm to insure the preservation of life.

The *loss of heat by bodies* is not nearly so rapid as was formerly believed. It takes place by radiation, evaporation, convection (the movement of air or water in actual contact with it), and by contact with cold solids. The rate is not constant, but grows less rapid as the temperature of the body is reduced, and is increased by an increased difference between the temperature of the body and its surroundings. It is materially changed by the various changes in moisture or motion of the surrounding air. Anything tending to increase evaporation will increase loss of temperature so long as there is moisture to evaporate. The actual loss of temperature should not be guessed at, but tested both by surface and rectal tests, or if the body is opened the surface of the organs may be tested.

It will generally be found that the body in ordinary room tempertures will give up from 1° to 2° F. per hour for the first twenty-four hours. The surface of the body will appear cold to the hand long before the mass of the body has seriously cooled, and the effect is partly psychic and in part due to the specific heat of the chief constituent (water) of the tissues.

It is difficult to dissect a body that is below 40° F. because the fingers quickly suffer from contact with the cold flesh.

Where tests are to be made the thermometer should have been recently standardized, as the variations are surprising. The thermometer should be nearly at the temperature of the part when applied. Much

interesting and valuable work remains to be done on the thermometry of the body, both as to the production and distribution of heat.

Muscular Changes.—Sooner or later we find the muscles losing their power to respond to stimuli. The power to contract under direct stimulation may be retained for hours after the response to the nerves has failed. Of course, muscles of the voluntary type that are complex do not contract as a whole, but the parts directly stimulated alone contract, the complex muscles acting as a whole only when the connecting nerves are intact. Involuntary muscles will often contract as a whole. I have often watched the intestines shrink on stimulation after death.

Tests of death, based on the loss of reaction, have been proposed.

Loss of Electric Excitability.—If the muscle responds as a whole and as if the nerve was functioning, so that several muscles connected only by nerves respond as a unit, then it is proper to say the body is not dead, but loss of excitability is not confined to death. The test is a proof of life if positive, but not of death if negative.

Chemical and *physical changes* in the muscle substances accompany, precede, and follow death, and much has been written on these. Unfortunately, not a little of this is nonsense.

The essential things for us to remember are:

(1) The muscles contain different amounts of muscle plasma which will coagulate under certain conditions.

(2) Acting muscle accumulates fatigue substances that tend to hasten this coagulation.

(3) Practically all the protein substances are capable of coagulation.

(4) Coagulation of the plasma may take place during life and may be recovered from.

(5) Contraction of the muscle is to a large degree, but not wholly, independent of the plasma. Therefore we may have contraction going on before or during coagulation of the plasma, and it appears probable that in life during cramp spasm it goes on after at least a certain degree of coagulation has occurred.

It will be apparent that the subject is sufficiently complex to excuse some of the confusion we find.

Rigor mortis, or cadaveric rigidity, is the result of coagulation of at least part of the muscle substance and appears to start with the plasma. The clot becomes firmer and probably involves the other parts of the muscle substance. It comes on quicker in recently fatigued muscles. It comes on earlier in the smaller and more active muscles that have smaller amounts of plasma, and hence resist fatigue less, such as those of the throat. It does not produce contraction, but may be associated with contraction caused by some other agent. Usually it is not associated with contraction. The rate of coagulation varies greatly, as does that of the blood, depending on the physical and chemical conditions. The firmness of the clot varies in a similar way; hence we have a very wide range of phenomena observable in the dead body, from a mere trace to extreme rigidity, and from the death spasm, which fixes

the parts or the whole body in the posture in which it was just before death, to a long period of relaxation followed by a long period of rigidity.

While rigor depends on such physical conditions or influences as heat, electricity, or the amount of fluids, it seems to depend far more on the chemical condition, especially fatigue stuffs and poisons. If these are serious we have contraction with the rigor.

The *period of relaxation* which usually follows immediately after death lasts a variable time, seldom less than two hours, usually more, but generally ranging from four to eight hours.

The *period of rigidity* varies to a considerable degree with that of relaxation, both depending largely on the same factors, usually lasting about two days, but the onset and fading being usually gradual, it is difficult to determine accurately.

The *passing off of rigidity*, or second relaxation, usually begins in the smaller mobile muscles—throat—and follows the general order of onset, both varying largely under local conditions.

The exact chemistry of the process being as yet undetermined, we can only point out the obvious fact that a substance so unstable as the coagulable substances will surely change in a very limited time, first coagulating, then softening. This is seen more clearly when we find that quick or slow onset is followed by similar fading.

Rigor with contraction is found to be the exception, and if this were not so the posture of the body after death would have little significance, but would be simply an indication of these changes. When heat coagulation is produced we have contraction due to the direct stimulation of the muscle by the heat. So at times we have currents coming down the nerves, either from physiologic action or the result of some direct excitation, or rarely simply a death current along an already open pathway (such effects are generally limited to a death twitch followed by relaxation).

The *position of the fingers and toes after death* has been variously regarded or disregarded. I find undertakers of large experience agree that they find the thumb drawn in under the fingers in a majority of cases.

The *facial expression* as found in the dead clearly proves that no serious contraction occurs with ordinary rigor, though we do see a slight change, which I attribute to slight shrinking of the clot in the muscles which draws up the muscles to a very much less degree than they were during life held by ordinary tonus. This clotting and shrinking is not confined to the muscles however.

Cadaveric spasm is a term that has been used to express the extreme condition of rigor and contraction, and is found when the muscles have been acting under strong stimuli, and not infrequently is undoubtedly due to violent stimulation through the nerves at the time of death, giving very considerable muscle discharge.

The *sphincters* are often said to relax at death. This is certainly not a fact, though often repeated. They do not continue to resist pressure as in life, and may be found relaxed, but only with cause; being

largely of the involuntary type, they seem to live on and die in spasm, furnishing an example of cadaveric spasm, though there is not a little difference in the degree of resistance, and at times one finds the rigor breaking down very early or but poorly formed.

As a *test* or *sign of death* lack of muscular irritability is of considerable value because its distribution is generally characteristic. There is a possibility of error in some rare conditions. Trance or hypnosis may be accompanied by rigidity, but it differs in type as well as distribution, and if broken down, may return; while fully developed rigor will not return if once broken, but if partly developed will partly form again simply by the completion of coagulation.

Cutis anserina ("goose-flesh") is often found in persons who die in the cold or who are placed in cold water or air before the skin muscles die. The retention of this in a warm place would add to the value of rigor elsewhere as a sign of death.

Fig. 1.—An Excellent Example of the Ordinary Blush Type of Lividity.

The areas where pressure had been exerted show a lighter shade. A faint mottling is to be noted. The muscles are seen to be bunched—specially the left thigh. This was clearly due to the contraction merging into rigidity. "Goose-flesh" was well developed. The man was accidentally electrocuted.

Color changes have been rather carelessly observed, and the errors have been quoted from book to book in a most interesting way. This is in a measure excusable when the observer does not see the body until it has been dead for a definite period prescribed by law, but not elsewhere. The *death pallor* which spreads over the face is due to two factors, not simply one, as is usually stated. The stoppage of the circulation naturally relieves the pressure in the vessels, and the tonus of the vessels, composed in part of the muscular and in part of simple elastic elements, being free to act, produce a blanching similar to true vasomotor blanching. The elasticity is lost but slowly, while the death of the muscles of the vessel walls is only delayed at most a few hours, but during these hours they are subject to various influences, such as heat, cold, chemicals, or electric potential generated by death processes. The result is

easily seen in recently dead bodies, and I have thought it wise to introduce photographs of examples which show mottling.

This **mottling** of the surface is not restricted to the dependent parts of the body; it is often found at the uppermost part at the time blanching is seen below; it differs with the condition of the body before death; specially is it found in bodies nearly exsanguinated by hemorrhage, in carbonic oxid poisoning, and may be extreme in asphyxia.

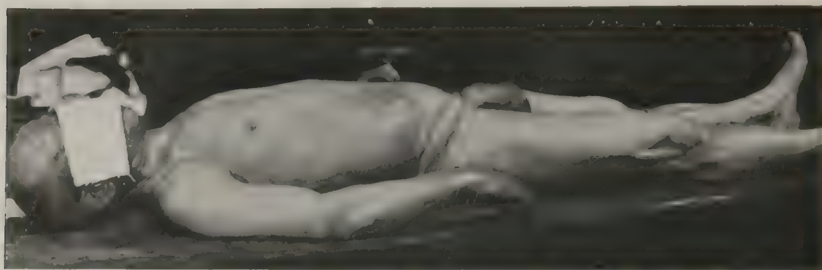

Fig. 2.—A Very Striking Example of Mottling Appearing Not in the Dependent Parts, but Here Seen on the Upper Part of the Belly.

I have seen this mottling change after death in such a way that no doubt is left that it depends on the dying of the blood-vessels. It does in a large degree depend on the postmortem blood-pressure, which may be maintained in two chief ways: first, by compression of the viscera which may be due to cadaveric spasm of the abdominal or thoracic walls, or by distention of the walls by swelling or pressure of the organs; second, it occurs by reason of the condition of the vascular system itself,

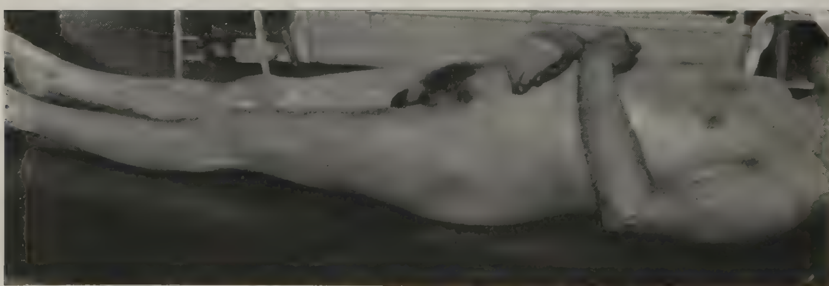

Fig. 3.—A Very Striking Condition.
The *lividity* is almost vivid enough to suggest a rash. There is no hypostasis. The man died of asphyxia due to edema of the lungs following poisoning by gas.

either by great fulness of the vessels or by spasm of the walls. No observing operator can fail to note the great difference in the bleeding one finds after death, yet few seem to have recognized the fact of a definite postmortem blood-pressure. The period of mottling varies considerably, generally lasting until rigor is well advanced. After this the main factor is the settling of the blood under the influence of gravity to the dependent parts. This action of gravity is continuous and occurs

in life, and it gains the ascendant only when the other factors weaken or fail, and it, therefore, is seen in great weakness, exhausting disease, or conditions which influence the local circulation. The amount of residual tissue life and the spasm in their death determine the onset after death of what is called *cadaveric lividity*, which is a settling of the blood within the vessels which is found usually some time after death, though this too is often greatly modified by conditions of postmortem blood-pressure.

After the body begins to decompose we frequently have gaseous distention and an increase of postmortem blood-pressure which tends to force the decomposing blood to the point of least external pressure, there to further decompose and spread decomposition. We then see

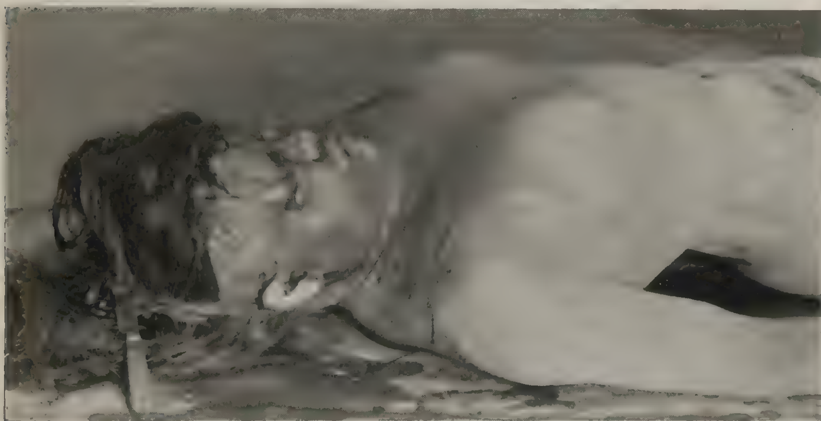

FIG. 4.—A STRIKING EXAMPLE OF A TYPE OF CASES NOT DESCRIBED IN TEXT-BOOKS. The belly is in very good condition, owing to having been constricted so as to prevent the decomposition from following distended veins. The face, neck, and upper chest were of a dusky purple and much swollen. The hair and outer skin were quite loose. In such a case it would be impossible to part the hair, so that the knife was introduced as shown and the cutting done by forcing the point between the skull and scalp. A novice would have had great difficulty in determining whether the extravasated bloody fluids in the scalp were the result of bruises or decomposition. Subsequently obtained data fully confirmed my judgment that they were not bruises.

areas of dark discoloration. If the body is constricted by clothing we find the face bloating and becoming purple, while the skin of the body may remain pink. If the chest is not constricted it will become congested; the scrotum frequently becomes greatly distended. After a period the blood disintegrates and gives rise to a green staining of the parts.

The **decomposition colors** are first dusky purple red, later darker red, then almost black, still later green; last of all, the green is oxidized to dirty yellow. When little distention takes place the green discoloration of the belly is common, but when rapid change occurs, or when the belly is constricted, the green belly is not found. I show a typical example of this, where the belly was quite pink, while the chest was green and the face had the puffy yellow of late decomposition. The corsets

had been in place during the weeks the body was in the water, and the decomposing blood was kept out of the belly walls by firm compression, but the tissues of the chest foamed and bubbled freely when cut, and the decomposing blood flowed freely from all the vessels.

It must not be forgotten that surface oxygenation of the blood is very general, especially if the body is kept cold.

Drying of the body is naturally early noted and most clearly seen in the eyes. This is often very rapid if the lids are open. The bulbar conjunctiva dries quickly and becomes translucent, allowing the pigment of the choroid to show through. The cornea dries white, and becomes relaxed and roughened. Gradually the eyeballs shrink.

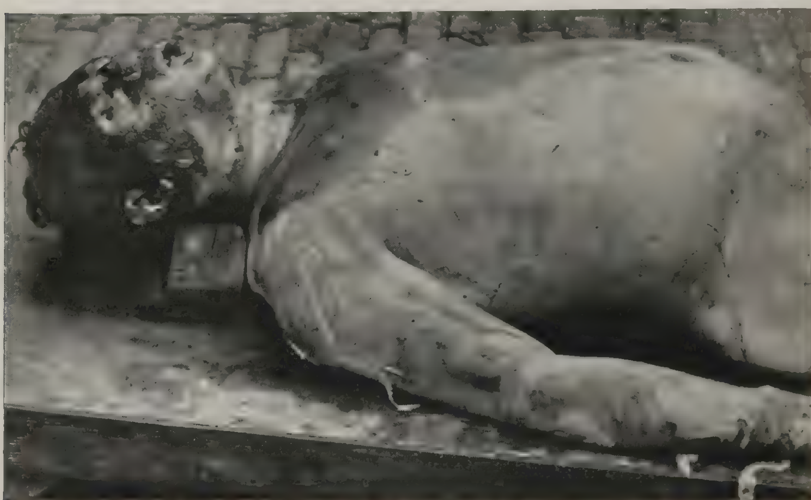

Fig. 5.—A Typical "Floater," or Body that Has Remained in the Water Until Raised to the Surface by Gases in the Interior.

The *outer* skin is separating with blebs. The decomposition in the veins produces a coarse irregular mottling seen most clearly on the arm. There is a *growth* of organized slime over the face. The tissues are distended with gas. The hair is very loose. The discoloration is most marked about the face and neck, rather than over the abdomen, as usually described in the books; the evidence of constriction about the neck resulting from a fairly snug-fitting collar. Postmortem bruises are seen over the eye and on the brow.

That this is not chiefly due to decomposition is understood when we note the eyes of the drowned, which often resist decomposition for a long time. The rate of drying depends on such a vast number of conditions that the results vary enormously, and the conclusions drawn regarding the time of death must be made with great caution unless all the conditions can be known, when such conclusions are unnecessary.

Usually the finger-tips are the best indices of the drying of the body. The tip of the nose is also a good indicator.

Other eye changes, such as could be observed with the ophthalmoscope, form an excellent proof of death, for nowhere else can we so clearly see the blood-vessels as in the retina. The use of various drugs in the eye as a proof of death has been suggested, but it has been found

that the eye, too, lives after death and gives a restricted reaction some time after actual personal death has taken place. The setting of the eyes in death is often spoken of, but it is chiefly a muscular phenomenon.

Decomposition includes the sum total of physical and chemical changes which occur in the natural disintegration of the body.

Putrefaction refers only to changes depending on the life and action of microörganisms. Drying and oxidation occur on the surface, but there are internal changes which would go on even in a thoroughly sterile body, though they are insignificant practically when compared with those of putrefaction.

The *time of onset* of putrefaction varies very greatly. I have had to cut bodies that apparently began to rot before death occurred, while other bodies naturally resist putrefaction.

Alcoholics, infected cases, those dying of heat or carbon monoxid poison, very fat persons, and those whose tissues are soft and flabby are apt to decompose rapidly, while thin, dry bodies with small compact organs are apt to resist putrefaction. External conditions of temperature and moisture are very important factors of the rate of change, temperature being the most important single factor. Drugs and chemicals, if present in large amounts, have some influence, though this has generally been overstated, because the amounts of such drugs found are rarely sufficient to produce any very great effect.

Chemicals introduced after death in considerable quantities have a very great influence on postmortem changes.

The Phenomena of Decomposition.—*Color changes* are most conspicuous and are largely dependent on the decomposition of the blood. In general, they correspond with those found in bruises in the living, only the blood in a bruise is outside the vessels, while in the dead body it is within the vessels for a time.

There are some very crudely incorrect statements current in the literature on the distinction between antemortem and postmortem extravasation of blood.

What we find in late stages of decomposition is not simply blood within the distended vessels; it is a fluid—no longer blood—which represents a mixture resulting from the decomposition of the blood and the tissues, and this is found outside the vessels and within what is left of the tissues or in tissue spaces. Shortly after the onset of decomposition the coloring of the red cells is dissolved out, and this fluid passes through the walls of the small vessels which are partly decomposed and actually stains the tissues.

This fluid *will not* drain away no matter how freely the blood-vessels are opened (except very slowly), and *will* drain away if the tissues are punctured with the least possible injury to the vessels. Many very serious mistakes have been made by would-be experts by taking such postmortem stains for evidence of antemortem violence. The formation of blebs on the surface is simply a continuance of this leaking process.

The *decomposition color scale*, as already stated, ranges from the bright red of carbon monoxid hemoglobin to dusky purple and deep blackish red; late in the decomposition the yellow element appears, giving first a green, finally a tawny yellow. If decomposition is retarded, so that oxidation goes on faster than decay, we have the bright red of

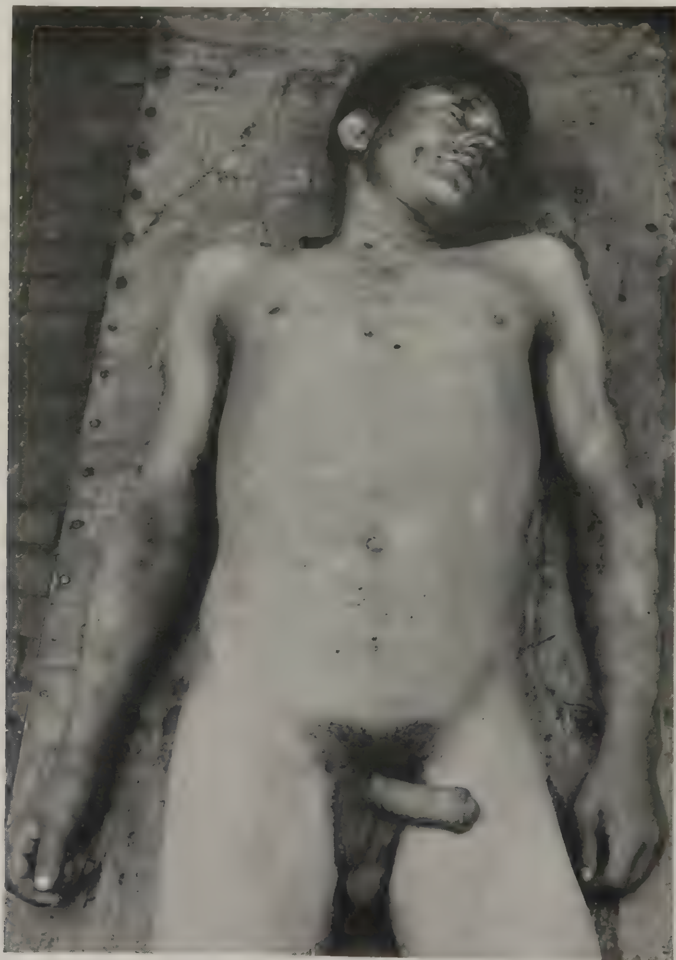

Fig. 6.—There is little evidence of decomposition about the belly, though the contained organs show considerable. The arms, however, are markedly discolored. Considerable difficulty arose because they were also bruised, and it was necessary to estimate the value of both the bruises and the decomposition because the man was beaten to death. The marks about the face show considerable violence, but the bruises here also had begun to decompose. Note the decomposition in the veins of the left arm and right thigh.

oxyhemoglobin. This is seen in bodies long kept in refrigerators, and this process can be seen very clearly about the edge of a spot that has been compressed, and, therefore, contains but little blood; there will be found a bright red border to the pale compressed area, while beyond will be found purple or bluish lividity where the blood is still reduced.

In old bodies various waxy or putty colors are found; these have little significance for us practically.

The *production of gas* usually begins in the belly and extends through the blood, but in cases where gas-producing infections existed before death gas is produced anywhere. Ordinarily gas is a rough measure of the extent of decomposition, but this is very variable, some decomposition going on without any gas production, while in some cases gas production is out of proportion to the decomposition.

Putrefaction as a proof of death is generally regarded as absolute. While local putrefactions are common enough in life, and in some cases of severe infection putrefaction is well advanced before death, such

Fig. 7.—What at first appears to be a mass of filth is really a most interesting and instructive case. The size, development of fat, condition of the centers of ossification, dentition, and a scrap of clothing enabled the relatives and the dentist to positively identify the body. The rapid development of adipocere with the extensive decomposition gave a clue as to what had taken place after death. The body had been in warm sewer water for several months. Note the sternal buttons (ossifying points) on the left breast; the group of epiphyses, that had entirely separated from the bones, in the upper left; the preservation of the liver, while the extremities are entirely eroded.

conditions could not cause serious question save only in time of some virulent pestilence. Besides color changes and those incident to the escape of fluids and gases, we have all those phenomena general to decomposition by bacteria—odor, liquefaction, shrinking or swelling, and distortion of parts resulting from these. Sloughing or separation of parts freed by liquefaction, specially of the outer skin.

The subject of the flora of dead bodies is very large and one that has received considerable attention, but is still so far from finished that it can as yet be of little service to us.

The odor of dead bodies proves that there is a great quantity of volatile poison produced, and those who have to work about such

bodies should, so far as possible, avoid inhaling these substances. Being sensitive to them myself, I can only warn others to be careful, and to bid them ignore entirely all negative statements from chemists, who have not yet arrived at final knowledge, as to there being no harm in volatile substances of this sort.

Decomposed Bodies.—It may be very important to judge rightly of the source of the putrefactive microörganisms, and whether they gained entrance to the body through wounds either before or after death, or were associated with disease, or were from the flora of the body. Such problems are difficult, and belong largely to the special bacteriologic investigations.

The destruction of tissue greatly interferes with all histologic studies and with many chemical investigations, and often destroys the evidence of disease so completely that one is not able to give any satisfactory account of the condition that existed at the time of death or of the cause of death.

Frequently one finds conditions even in bodies much decomposed that amply repay the toil and discomfort, but the interpretations are difficult. No very great help can be given in this matter, but it must be held clearly in mind what decomposition does to the various culture-media, and then consider what sort of media the tissues afford. This, with a careful comparison of the effects produced in the various groups of tissues, will give much insight into both the previous condition of the organs and the nature of changes of decomposition. The factors of liquefaction, gas production, laking, drying of the remaining framework of indifferent tissues are the main things to study.

Postmortem changes in the various organs follow the general principles already laid down, but they give us a most valuable insight into the quality of the structure of these organs. Each organ has a framework or fibrous skeleton into which the specifically changed cells, constituting the true parenchyma of the organs, are built. The parenchyma softens or undergoes liquefaction by decomposition rapidly and leaks out, acting in a way like a sponge in the rotting pens after being gathered. Where the skeletal structure is well developed, as in the lungs, the organ retains much of its form after advanced decomposition. Where there is extremely little of such material, as in the brain, the whole mass quickly goes into a state of mush. Where there is a variable amount, as in the kidneys or liver, we find even in decomposition a good indication of the condition of the organ, although very considerable rotting has occurred. Wherever the fibrous structure has been increased, it is apt to remain.

The *fat* may prove very resistant owing to there being little for the particular microörganism to feed on, and may, if ammoniacal fermentation has occurred in nearby organs, be converted into an ammonia soap that is very permanent, or it may separate out as oil, which may have a preserving effect, specially on the dried skin.

To determine the time of death from the condition of the body is certainly at times desirable, but it is by no means a simple or easy undertaking, though one constantly is made aware of rash statements made by persons entirely lacking in the necessary equipment for such work.

It is far better to make any such conjecture with very broad limits unless one has carefully balanced all the factors.

Not a month goes by without some case where some inexperienced and incompetent person has made a glaringly crude error regarding the time the body has been dead.

Even experienced undertakers, who know much more about the dead body and its various changes than the average medical man, make mistakes. Knowing the variable times at which rigor, lividity, cooling, and putrefaction commence, and the variations in the rate at which they progress, one must be careful in drawing conclusions.

I do not conceive it possible to lay down any more definite rules for such estimation than are embodied in the principles already outlined under the various postmortem changes which take place in the body.

It may be useful to have a brief *summary* of the **proofs of death,** or the means of verification of death.

I. Arrest of circulation.

(*a*) Absence of heart-sounds and of pulse. (Good.)
(*b*) Failure of a cut artery to bleed. (Best.)
(*c*) Changes in color. (Useful at times.)
(*d*) Coagulation of blood. (Rarely useful.)
(*e*) Failure of the veins to refill. (Misleading.)
(*f*) Reaction on injection of ammonia. (Only useful some time after death.)
(*g*) Injection of fluorescein into a vein. (Only fairly good.)
(*h*) Reaction after burning or blistering. (Not good soon after death.)
(*i*) *x*-Ray examination of heart. (Excellent if technic is good.)
(*j*) Lack of pink color with fingers in front of bright light. (Good.)
(*k*) Mirror on the epigastrium. (Good. This also shows failure of respiratory motion.)

II. Arrest of respiration.

(*l*) Arrest of respiratory motion of chest and diaphragm. (Often misleading.)
(*m*) Arrest of motion of air at the mouth and nose.

III. Changes of temperature.

(*n*) Reduction of the internal temperature below 90° F. (Good.)

IV. Muscular changes.

(*o*) Loss of response to electricity. (Good.)
(*p*) Rigor mortis. (Very valuable if properly observed.)
(*q*) Loss of reflexes. (Practically worthless.)

V. Color changes.

(*r*) Pallor. (May be valuable or misleading.)
(*s*) Lividity. (If fully formed and clear, excellent.)

VI. Drying—

(*t*) Of eye. (Usually excellent.)
(*u*) Of skin. (Too slow to be of value.)

VII. Ophthalmoscopic examination. (Excellent.)

VIII. Decomposition. (Positive, but too slow.)

PART II

TECHNIC

WHILE anyone with care and a moderate degree of ingenuity can develop a fair technic, a really good technic requires much more thought and pains than most men have time to develop without at least the help of suggestions. It is surprising how one overlooks the simplifying devices and methods in the press of work.

The literature on postmortem work is remarkably deficient, and for that reason I shall go rather fully into some of the methods I have found useful, realizing that some of these will appear too obvious to those who are familiar with them already, but realizing as well that what is familiar to some will be quite new and valuable to others.

The first thought should be to have the necessary kit of tools for the work. The discussion of the instruments will be taken up in detail later, but the general principles may occupy us for a moment. It is well to have a separate bag with a good working set of instruments always ready packed for use, and it is not improper to consider the effect on the onlookers of having a professional appearance in matters of this sort, for one has to remember that even the best men prefer a little style.

I always carry my bag and I try to have my tools fairly clean and in order, but there is no reason why one cannot make an excellent operation with the simplest sort of tools.

I have made many postmortems with a small butcher's knife and a butcher's saw and sewed up with a sailor's needle, the total cost of these being less than that of an ordinary postmortem saw. It is better to have a kit because one can work a little better with one's own tools than with any others; but as skill grows, simplicity of apparatus for routine work increases, though, for really difficult work of a special sort, the tools multiply rapidly, and the expert operator is glad to avail himself of all possible instrumental aids.

Having, then, selected his kit to his needs, and being armed with proper authority for the examination, he proceeds to the place selected.

If this is a residence the operator, if possible, has the undertaker meet him at a prearranged time. The body will be found in some room of the house, usually one of three places—the room (*a*) where the person died, (*b*) the parlor, or (*c*) where the services are to be held. It is always better if possible to avoid carrying the body about, as the effect is not reassuring to those in the house. When it is clear that such moving will not annoy people, or when conditions actually demand it, the body may be moved to a selected room.

The best room is usually a second story front room. Arrange to have the body in the best possible light, which is usually secured by placing the head toward the window.

Next best is to have the left side toward the window, the operator habitually standing on the right side of the body, unless he is left handed.

Get the movable furniture out of the way as completely and as quietly as possible. Have the basin and bucket as near the right hand as may be.

See that the windows are protected, so that the neighbors will not have a free show.

I usually borrow an old sheet, tuck one corner behind each of the sash cords, and pull through until I have a good curtain that can be pushed up just far enough to obstruct the view of the curious and no farther. This saves the fuss and noise of pins and tacks and is better, for once placed, the curtain will not fall down.

If the body is on the bed a couple of old sheets or several newspapers may be spread to prevent soiling the surroundings.

Make all necessary arrangements so that when you are through nothing will be seen to show you have made a postmortem in the room except the dirty water in the basin and a small roll of soiled papers or rags.

If the *light* is not what it should be, you will have to tax your ingenuity to improve it. I have hung up a sheet to reflect light on the body; even put one on the floor in the sunlight in an adjoining room which could not be used. Gas-light is only to be used when necessary; incandescent electric light is no better; oil lamps are worse.

Incandescent mantles burning gas or oil vapor give a usable light, but there is need of care that they do not shine into the eyes of the operator. No matter what light is used, it should be so shaded as to protect the operator's eyes. This matter is far too frequently neglected. Where one Welsbach light can be combined with two ordinary burners we have an approach to natural light.

Tungsten filaments give what appears to be a white light, but they will be found to give bad color values, as was only recently found in the gallery of the Philadelphia Art Club, where they had been installed on the assurance of lighting experts as a perfect white light. They had to be removed. Whatever light is used must be noted, and its intensity and quality most carefully estimated. Daylight still remains the best light for operating. Where I am compelled to operate in artificial light, I take parts out into daylight afterward to be sure I have properly judged the colors.

On What to Place the Body.—A bed is perfectly satisfactory if it can be easily moved and has not too high a footboard. The undertaker's cooling board is apt to be shaky and requires at least two persons to handle, and is about the most unsatisfactory device I know of, as the examination of the back is made very difficult and cutting the head is not helped.

The old-fashioned ice-box, with a stout board in the bottom, with four handles, is much better; the ice-pans are often too heavy, however, and stick. The head end of the board can be raised and made to project a short distance beyond the end of the box for operations on the head, or the box can be lifted from its supports and placed on the floor and the bottom board raised and placed diagonally across the top. Anything weighing over 300 pounds had better be examined on the floor, the operator kneeling, preferably on a pad.

In **lifting bodies** there are a few worth while bits of advice:

(1) Never hold the breath; rather breathe freely for half a minute beforehand and avoid straining lungs and blood-vessels.

(2) Have the back as straight as possible, and lift with the legs as far as possible.

(3) Avoid lifting when possible.

(4) Remember that there is small chance to handle the body without some stiffening apparatus, and if no stretcher is available the best way is for one person to place his right hand at the back of the neck, his left under the chin, and the other person grasping the ankles, both pulling as if to stretch the body. The man at the head end keeps his arms close to his body. Large bodies require a third person at the buttocks.

(5) Never try to take up a body around the waist as if wrestling—the compression of the belly is very apt to produce unpleasant results.

(6) If the body is light, one arm can be thrust under the thighs, the other under the thorax.

(7) If the body is large, pass a loose loop about the body under the arms and another above the knees, somewhat tighter. The forearms may be inserted to the elbows in these loops, and the back being fixed, the legs are brought into play in the lifting.

(8) A stout blanket, gathered above the head and below the feet and pulled lengthwise, makes a fair stretcher.

To take off the clothing requires some skill. The tails of the coat are pulled out beyond the head, while the upper part of the body is raised by the hands. The arms are then brought above the head, the hands touching, the coat sleeves pulled a few inches so as to help hold the arms, and the collar is slipped over the occiput, then the sleeves are pulled from the arms. The shirts are turned inside out with the hands up over the head. The trousers are first unbuttoned and freed, then the feet are crossed and raised in one hand, high enough to reach under the buttocks and grasp the top of the back, which is drawn down free of the buttocks, then the legs of the trousers are pulled from the bottom.

Women's clothing must be removed in layers and segments, depending on the mystery involved, but always remember the fatal pin, which is usually dirty, gives an ugly wound, and has no respect for rubber gloves or the male hand. Of course, in special cases, as in many medicolegal ones, clothing is to be cut off, but in such a way that it can readily be put together again, and the cuts must not destroy evidence.

Formaldehyd is used so extensively by undertakers that one is often choked and blinded by the gas. A little ammonia-water is a great help in such cases; it forms a chemical union with the formaldehyd. In the earlier years of my work my eyes became extremely sensitive to this gas, and I suffered greatly without gaining any relief from the eye-washes of the ophthalmologists until in desperation I decided to try chlorate of potash; the result is, I now use it regularly on conjunctivitis, 1 to 2 per cent. in a saturated solution of boric acid in an eye-bath. Where formerly I suffered because I did not recognize the obvious fact that mucous membranes are much alike, and no one helped me, now I know where I can get relief.

Frozen bodies must be thawed out before they are dissected, though they may be examined, this is specially desirable in medicolegal cases while still frozen, and directions can then be given for the proceedings.

It is generally held that the body should not be thawed out in water, though I fail to see any objection if the exterior is examined first and the water is not heated above 80° F.

As moderately warm air is less troublesome and not objected to, it should be used except where there is reason for haste. The air should not be above 70° F., and the body should be very lightly covered.

Fat bodies appear to be frozen when it is only the fat which is hardened.

If possible, the temperature of the body should not be below 50° F., but modern refrigeration usually cools it to a much lower temperature; if possible, it should be allowed to warm up by being exposed at room temperature for an hour or more if it has been thoroughly chilled.

Dirty bodies offer many troubles. The nature of the dirt may be of great importance, as in medicolegal cases, when it is necessary to fully investigate the whole matter. Undertakers and attendants of all sorts have a genius for destroying evidence in these as in other cases.

Where no significance is attached to the dirt, it may be removed in the way best suited to the conditions, provided always that no change is made in the body. Hot water, strong chemicals, and rough handling of all sorts must be avoided.

I find several methods, in the following order, of use:

(1) Dry wiping with old cloths, always being gentle.

(2) Softening with damp cloth or sponge and clear water.

(3) Wet wiping, with possibly a little soap in the water.

(4) A gentle current of cool water, aided by gentle rubbing when necessary.

(5) Most careful scraping with the edge of a dull but perfectly smooth knife.

(6) Only in extreme cases should scrubbing be allowed. In general, gauze is better than a sponge. For vermin I prefer to use a little chloroform on a bit of gauze. Larkspur, fishberry, bichlorid, and formaldehyd are all recommended, but are apt to change the tissues and should not be used in medicolegal cases.

Dry, clotted blood, after being carefully observed, can be cracked by

rubbing dry with a small surface of gauze or scraped off. Wet scrubbing is usually slower.

Embalmed Bodies.—The details of embalming and the effects of fluids are taken up in a special section. The process varies so, both as to manner and degree, that one must be sure just what has been done before any assurance can be had that the body will keep, or that there is more than a pretense of embalming. While certain workers are very thorough and take a pride in their results, there are a lot of half-trained embalmers who miserably skimp the job. The nature of the fluid should be ascertained and the amount used and the channels into which it was placed.

In certain States the law forbids the use of certain poisonous fluids in embalming. I have known undertakers to use them mixed with formaldehyd, and not tell the truth as to what has been done. This is not common, however.

Undertakers, as a rule, are, aside from their charging for the most palpable shams, a very decent lot of men, and their work gives them an opportunity to observe the dead body as no one else does. Their relations with the family gives them considerable power to hurt or help a physician, and they resent and despise the rough and sloppy work done by careless operators who make postmortems, and their reports, not infrequently made as to how a postmortem has been performed, have caused many a family to refuse to allow any more autopsies. To be sure, a cheat who has botched his work now and then blames the doctor for his failure. The statement that a body cannot be properly cared for after the head has been cut is not an uncommon one, and always marks the utterer as incompetent or crooked. That a recklessly made postmortem interferes with the work of the embalmer is clear enough, and that the work is rendered difficult in proportion as the blood-vessels are destroyed is a simple fact, but modern embalming is not so crude an art as to be completely upset by an ordinary postmortem.

It is, however, eminently proper for every operator to consider the undertaker and his duties in preparing the body after it has been opened. Such decent consideration is far too often neglected, especially by young and thoughtless hospital residents. The stories which thoroughly reliable undertakers tell me of their experiences would be hard to believe if I had not seen just such abominations with my own eyes. The wonder is we get as many permits as we do.

I have found that the respect of the good undertakers is worth having, and I have always been as considerate of them as the nature of my work permitted, and I have found that such consideration has been almost universally appreciated by the decent ones. As to having the undertaker present at the examination, that is a matter which depends on circumstances. In certain medicolegal cases I exclude them, and where I know they are dishonest I do not seek them or encourage their presence in ordinary cases. In ordinary cases I am generally glad to have them, because they are handy with the body and their presence gives the family a better feeling about the care of the body. They can usually tell you something about the case that is worth knowing, and

they usually are glad to exchange knowledge they have gained for some information you may have. Unfortunately, a limited number of men in each business have to be knaves, and against such we must be on the alert. Undertakers are no exception, and a really bad one is a very undesirable person to have present at any time, specially at a serious postmortem examination.

MORTUARIES

In large cities we find the hospitals providing more or less suitable *mortuaries*. Curiously enough, the religious orders which discourage postmortems and make much of the sacredness of the dead, make the least provision for the care of the dead, and in not a few large hospitals that I visit the rooms and the care of the bodies is simply disgraceful, The tendency of the managers and trustees is to avoid the dead-house. as it is unfortunately called, and the orderly who has charge there is usually the least competent employee of the institution, and the conditions are a disgrace. Such a state of affairs tends to encourage the young residents in their laxness, and should be remedied.

The **situation of the mortuary** should be given thought in the building of the hospital, and not left to an architect who knows nothing about hospitals. Of the thirty-five hospitals in which I have made postmortems in Philadelphia, nine have separate buildings more or less suited for such work, and fifteen have rooms that are at least partly equipped. A study of these would furnish a long list of things one should avoid in the construction of such a room; perhaps it will be more useful to consider what things are desirable in such a place.

Suggestions for building or bettering conditions which will enable hospitals to do better work. If possible a laboratory building should be built well separated from the rest of the hospital, so as to allow plenty of air and light, but be connected by a tunnel with the main buildings to avoid the necessity of carrying bodies through the open yard. To lift the bodies to the operating and refrigerator rooms an elevator may be used, but such luxuries are expensive and a gradual incline is often just as good. The room should have a north or, better still, a north and east exposure, but, by using ground glass in the windows, southern exposure will do perfectly well. The ground floor is best where land is cheap, but in large city hospitals this is hard to arrange. A basement room should be avoided if possible. Provision should be made for a refrigerator large enough to meet the extreme limit of deaths in the hospital for three days.

The **size of the room** will depend on available space and the sort of work to be done (whether for investigation or for teaching).

The working space should not be less than 15 feet square, and at no time should any side be less than 12 feet.

If the room is to be a laboratory as well, it may be oblong, but the better way is to have a nearly square room.

In **placing the mortuary** and **postmortem rooms** one should avoid having them too near either the boiler-rooms, the kitchens and dining rooms, or near heavy machinery, such as laundry or dynamo room.

There will be odors that are very offensive to the sick and equally obnoxious to attendants off duty, who need some consideration. The fear that a postmortem room is a pest-room that should be placed at some remote corner, wholly inaccessible to everybody, is a great source

Fig. 8.—Postmortem Room, Jefferson Hospital, Philadelphia.

This room demonstrates what can be done with a cellar. The floor laid in cement of moderate sized blocks. Seats and rail for students all in one piece composition work. At the left is the refrigerator opening into the room and into the outer hall. Note table with stone top draining into the large sink and swinging in a semicircle, sanitary hand sink at right, scale table. Note table, instrument case, and metal wardrobe. This photograph was taken by the electric lights ordinarily used. (Courtesy of Prof. Wm. L. Coplin and the Hospital.)

of trouble, and should lead rather to the proper care and regulation of the room than to its removal to a distance, for flies can travel across any hospital yard and attendants can carry filth very readily. In the old days, before bacteriology showed us how infection arose and how it could be avoided and the postmortem room was a charnel house, such isolation

was quite excusable, but now there should be a modernizing of our conceptions so that the room be kept as sterile and clean as any other operating room, with the windows carefully screened, and it should be accessible, cheerful, and even attractive.

A surgeon should have no more hesitation in going from a postmortem operation to a case than from one operating room to another, for the body acquires few pathogenic germs after death.

Due regard should be had for the handling of the body, bringing it from the wards, delivering it to the undertaker, and carrying it from the refrigerator to the table and back. All sharp turns, narrow passages, and curved stairways, small elevators, or other obstructions will surely

Fig. 9.—The Most Elaborate Postmortem Room in this City, Philadelphia.

The table is fixed; has marble sides, slate top, drains to the middle, has a ventilating scheme and complicated overhead light, and water combination. The room has painted and tile walls, small tile floor, light on three sides. A large hopper sink with a flush box and mixing faucet, two hand sinks. The steam coils are suspended. (Instrument case suspended, refrigerator opening into room and outer hall. These not seen in photograph.) No drainage for floor on which the small tables rest rather than being suspended from the walls. (Courtesy of the Pennsylvania Hospital.)

cause annoyance and trouble, and the upkeep and repair will always be large because walls and woodwork are sure to be battered if foolishly planned.

The **construction** should be such as to insure dry walls that can have a hard white finish. The floor should slope just enough, to an easily cleanable drain, but not enough to interfere with the even standing of tables, and should be made in one piece. This can be obtained by using asphalt or some of the new composition floorings. Marble is to be avoided; brick is worse; tiles offer too many cracks and joints, no matter how well laid. Cement does not hold up well in large surfaces, and when cracked is not cleanable, but, if laid in small blocks and covered by an elastic surface, works well. If it is necessary to use wood, it should be

thoroughly shellacked at all times. After the shellac accumulates it is best dressed by brushing it with extremely dilute varnish rather than adding coat after coat of the thick sort, as cracking will thus be avoided.

There should be at least one large window with large glass, so as to avoid shadows from window bars. The ventilation should not be obtained by such a window. The various expensive devices for direct table ventilation are usually failures and worse than useless, as they get filthy, are hard to clean, are usually neglected, and are almost invariably found not working. I have no objection to a large ventilating hood, such as is found in modern hotel kitchens, being placed over the table, and having the lights suspended from the middle of it; it should be 7 by

FIG. 10.—Note the way the grooves are cut into the slate top; also the floor of concrete sloping to a point under the table. (Overhead water, gas, and electric light.) The central drainage works, but the down draft ventilating scheme is not a brilliant success. Probably more postmortems have been made on this table than on any other in this country. (Courtesy of the Philadelphia General Hospital.)

4 feet, and be placed 7 feet from the floor and have an electric fan on the draft pipe, which should be at least 10 inches in diameter. Such a hood should be painted with white bathtub enamel inside and outside. The ceiling and walls should be as nearly white as possible, and any window curtains should be white. I find gauze an excellent substitute for ground glass where south or west light alone can be obtained, and this can be mounted on swinging frames fitted to the window-frames, so that the windows may be opened and air and light may enter freely, but flies, dirt, and undesirable observers avoided.

Fittings.—There should be at least one good sink, preferably of heavy stoneware or porcelain, not less than 18 inches wide nor less than $2\frac{1}{2}$ feet long. The water—hot and cold—should be united in a long

nozzle, placed from 15 to 18 inches above the bottom of the sink, and this should have a short piece of rubber hose attached. A good hopper (a water-closet will do) is a desirable part of the fittings, because the waste must be emptied while one is using the sink.

Most pretentious rooms have water over the operating table and a sink under the table. When the surgeons find such devices desirable I may be converted to their use, but all of the ten different sorts in the hospitals in Philadelphia where I have made hundreds of examinations are undesirable except for sloppy workers. My own preference is very strongly for a clean floor without a single permanent fixture or piece of furniture resting on it. Sinks, closets, laboratory tables, and all such devices should be bracketed to the walls, and the operating table should be easily movable.

Everybody agrees that there should be an **operating table,** but nearly everybody has some fancy as to what it shall be like, either as to size, shape, material, or construction. Most tables are built too high for first-class work. My rule is that the top of the table should just touch the knuckles of the closed fist of the operator standing close to it with arm hanging naturally, or so that the elbow will be above the top of the body to be cut when in place on the table. Of course, this may be attained by having a board platform to stand on. This has the advantage of easing the feet if there is a hard floor, but has the great disadvantage of not being easily cleaned. I prefer a table about $2\frac{1}{2}$ feet high and a strip of thick linoleum to stand on. The table should be from $6\frac{1}{2}$ to 7 feet long and from $2\frac{1}{2}$ to 3 feet wide. The framework of the table may be of wood, thoroughly varnished with shellac, and free from all ornamental absurdities, or it may be of iron. Gas-pipe furnishes a very good, cheap, and easily obtainable frame. This should be not less than 1 inch in diameter, and the threads should not be cut so far down as to prevent their being entirely covered in the joints. Pipe of galvanized iron can be used, but it is rough and is hard to do over, which it is well to remember is required every year or two.

Nickel is less desirable as well as more expensive, though good for a demonstration room table, where a good attendant is to be had who will take care of it.

Smooth iron pipe, treated first with a coat of red lead and then two coats of good bathtub enamel, is most satisfactory, as it can be done over as often as necessary. The framework should be smaller than the top so as not to be in the way of one's feet and not to catch any accidental spill.

For demonstration rooms, or where the light comes only from one side, the table should be freely movable on large wheel castors. The top of the table may be made of stone or wood covered with sheet metal. Glass or porcelain are apt to be too slippery, though I have in mind a most convenient table with a thickly enameled top that works wonderfully well (Fig. 11). The only stone that is fit for the purpose is a hard close-grained slate which has been treated with oil after it has been worked into shape. This is too heavy for a movable table, but is a great favorite with all plumbers and most builders of tables.

Plain wooden tops are fairly satisfactory when they can be thoroughly cared for, and for this purpose plain asphalt varnish seems to be about the best finish.

Much more satisfactory is the cover of sheet metal. Either galvanized steel or, better, a zinc-covered wooden top or, best of all, a tinned copper cover molded over wood. The edges should be raised about 1 inch, and I prefer to have this half-round rather than with a sharp angle or a square border. There should be a slope to the foot end of about 2 inches. I have no objection to having a drain at the foot end of the table, provided it be made so that it can be kept clean.

Fig. 11.—Operating Table.

A table made for undertakers, with enameled iron top, having a rounded ridge at the edge, draining to one end, where a bucket hangs; supported on a very firm round base which has strong castors. The table can be tilted or raised readily and clamped, is freely movable, and is narrow enough to allow access from either side without moving the body. A very good table for demonstrations and for general work. The body shows marked trophic changes of brain disease. (I am indebted to Mr. Oliver H. Bair for permission to take this and other pictures in his splendid establishment.)

This can go to a bucket either on a shelf or hung on the framework, or may lead to the drain in the floor, or the end may project over a working sink, either in the room free or by the wall.

The placing of running water over the table is a temptation to slop and splash in a way that is very uncleanly and injures the work.

As part of the table fittings we usually consider **head-rests.** They are generally made of wood and are varnished. Several forms are shown in the various figures.

They may be cut from a block of clear pine, not less than 3 inches thick. I find a V-shaped notch holds the head better than the common

U-shaped one. A good, fully equipped room should have an assortment of not less than half a dozen of different sizes and heights.

Fig. 12.—Note white tile partition behind which students sit. A very elaborate table with scales attached. Central drainage and air-shaft intended for ventilation; copper top and overhead water; also several forms of head-rests. The electric light has a suitable reflector, but must be held by hand, and is, therefore, never still. Small tables are covered with oilcloth. (By courtesy of the Hospital of the University of Pennsylvania.)

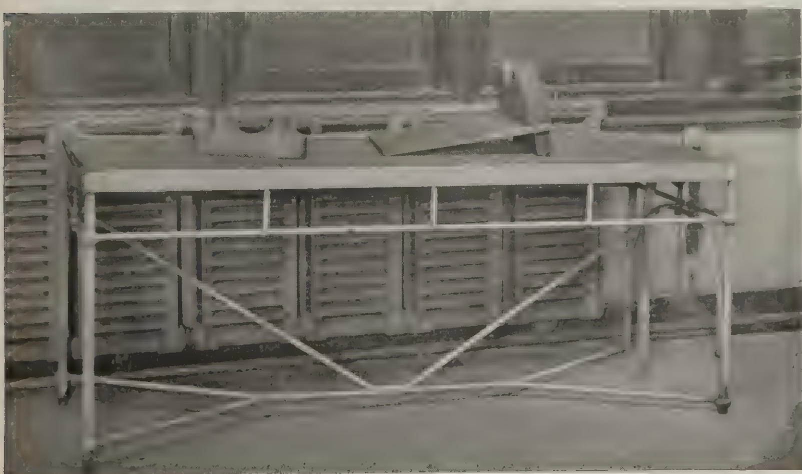

Fig. 13.—Table at City Morgue.

I use it chiefly as a laboratory table, but it illustrates elaborate unfitness. Frame of iron pipes, top of slate, grooved to carry fluids to the right or lower end, where there is a drain-pipe. Two useful forms of head-rests are shown.

Head-clamps are generally unsatisfactory, being hard to attach firmly, are generally in the way, and do not help either those who can or

those who cannot handle a saw properly. There are many things that can be used at a postmortem which add to the comfort of the operator

FIG. 14.—A CORNER IN A POSTMORTEM ROOM, WITH SIMPLE DEVICES.

The shelf consists of two boards bracketed together, into one of which are screwed brass curtain fixture hooks to hold graduates, etc. On the shelf, porcelain mortar, several "Acme" graduates, acids under bell jar, black and white tiles. Note the reagent bottle rack which holds forty-eight bottles and can be lifted and put away on a shelf. Also the closet with flush; this is a very essential part of the equipment. The cheap table and stool are light and strong, and when coated with shellac can be kept clean. Note the ball of string on a towel rod at the right.

or to his efficiency directly which I mention simply in order to bring to the mind of the person arranging a room:

Stools of different sizes, as plain as possible and well varnished.
Basins, preferably of white enamelware, different sizes.
Trays, also of enamelware, of all sizes, mostly shallow.
Dissecting boards (see figures throughout book); very useful.
Desk for taking notes and keeping records and blanks.
Work tables on which dissections can be made, at least two.

FIG. 15.—Shows how much can be done by ordinary hospital mechanics at a very low cost. Note white enamel walls, shelf with graduate rack, zinc splash-board and draining shelf; home-made double water faucet, deep sink; good form of Welsbach light; large drawers for supplies. (Courtesy of Philadelphia General Hospital.)

Closets and Cabinets.—At least—
One for instruments and apparatus.
One for jars and glassware.
One for reagents and chemicals.
One for specimens.

Provision should be made for *storing supplies* for various purposes, including cotton, gauze, soap, towels; repair appliances, such as bandages, plaster, and twine.

Racks for graduates and cleaning appliances.

Disinfecting materials, including fluids, dishes, and appliances.

Jars and **bottles** for the care of tissues and organs.

Special illumination wires if electricity is to be had, burners if gas is used, and suitable reflectors and shields. Light must be supplied over all sinks and work tables as well as over the operating table.

Special examination tables where laboratory work is done in the operating room for chemical, microscopic, or bacteriologic work. Bun-

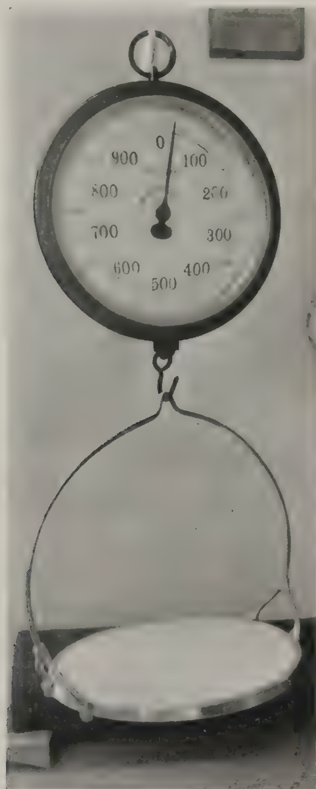

Fig. 16.—A Convenient Form of Scale, Weighing to 3 Kilograms.

The porcelain pan could be covered with an enameled tray or pan. This form is far cleaner and handier than those requiring weights, and is as accurate as is consistent with the class of work usually done in weighing organs.

sen burners or alcohol lamps. Various dissecting trays and glass vessels to hold organs while making careful dissections either in air or water.

Photographic outfit generally omitted; unfortunately, without reason, but to the great loss of science.

Simple hoods to carry off the foul odors will be introduced, I trust, at no distant date, and various methods of artificial ventilation along simple practical lines.

If teaching is to be carried on, provision for a place where the students

or observers can be comfortable without being in the way, interfering with the light, or having strong lights shining into their eyes.

The **heating** should be so arranged that the steam-pipes or hot-air openings will be well above the floor. They should be above the cases and shelves, which, in a room of ordinary size, should occupy most of the free wall space.

Fig. 17.—Room Fixtures.

Shows how space can be utilized. The window has been closed and a shelf placed at a suitable height for the scales, 1, which can be used for ordinary chemical work, organs, or specific gravity; 2, a useful cheap spring balance; 3, pair of skimmers for volume and specific gravity work; 4, glass jar for volume and specific gravity of largest organs; when in use a large block is slipped underneath; 5, very useful electric light stand, adjustable, with metal shade reflector; 6, section board arranged for dissections by placing several non-corroding metal screws on each side to which retractors can be attached; 7, common kitchen table, coated with shellac—light, clean, cheap, easily moved.

Provision for scales should be so placed as to do away with the soiling of the floor, preferably by hanging on a swinging arm, which can be brought over the table or over an adjacent working sink; or they can be hung up temporarily on a hook in a suitable place. Specially accurate weighing should be done by placing the prepared organs or tissues on a

clean tray and carrying them to the apparatus, which should be on a suitably located and built shelf or in a cabinet. The construction of these shelves and closets and tables will depend largely on the available funds. Simple wooden structures are perfectly usable, and may be protected by either shellac or asphalt varnish, or they may be covered with sheet zinc or, better, with tinned copper. Glass is expensive, does not last long with ordinary care, and stone is still more unsatisfactory. Cherry wood is the best for laboratory purposes, and an abundance of shallow enamelware trays gives by far the best practical solution of the problems of cleanliness and usefulness.

Supplies.—A rather large experience in all sorts of laboratories has taught me the need of having a good, well-kept lot of supplies, and for the benefit of those who have had less experience I add a practical list of requisites:

Towels.—The best general laboratory towel is cut from the piece and hemmed. Should be of fair quality of linen and of two grades—one of the rather thick sort sold for dish towels, the other known as glass toweling. They should be cut into lengths of about 2 feet.

Soap should be had in five forms:

(*a*) Bars, such as Ivory soap.

(*b*) Powder, such as Gold Dust.

(*c*) Scouring powder, such as Dutch Cleanser.

(*d*) Scouring soap, such as Hand Sapolio.

(*e*) Liquid soap for the hands. This may be made from good soft soap or Gold Dust or bought in bulk, and may be kept in a dentifrice bottle.

Disinfectants.—Crude carbolic acid dissolved in water, with 2 or 3 per cent. of lye added, can be kept in a tall covered pail and applied to infected surfaces by means of a short-handled mop. A small watering-pot is a great help in spreading it. The use of the ordinary house mop is most undesirable, as it smears the diluted filth. A small rubber squilgee or squeegee is cleaner than wiping cloths, and saves the hands of the person using it.

Plaster of Paris, for repairing the skull, is best kept in the large covered tin buckets in which dental plaster is sold.

Raw cotton (not absorbent) is the best material to use to restore the contour of parts after dissection, and, owing to its highly inflammable nature, it should be kept in a tin, such as is sold for keeping bread.

Gauze is so much cleaner and better than sponges that if possible a roll of some cheap sort should be kept in stock, from which pads of $\frac{1}{2}$ and 1 yard can be cut and folded. These can be washed out as easily as sponges, and can be much more readily dried if it is necessary to economize, or they can be burned. For fine dissections even smaller pads are better.

Sponges can be used if one has gotten accustomed to them, but they should be rinsed out, after washing, in a dilute carbolic solution before leaving, and should be either hung up by strings or kept in wire baskets to facilitate drying. Hot water very quickly spoils a good sponge.

Twine should be stout and not tightly twisted. I use a four-strand gill-net twine. The use of fine or cheap thread is inexcusable, because it tends to cut out and break. Fine silk for the repair of exposed parts can be kept in a small box with suitable needles.

Bandages of stout muslin, 3 inches wide, are often useful.

Refrigerators are now very generally built into a part of the mortuary. One is to a large degree limited to what the dealers will provide,

Fig. 18.—Individual Compartments for Holding Bodies.

Note the complete isolation as well as protection against all sorts of vermin and animals. Absolute cleanliness; security by separate locks; absolute simplicity of surfaces so as not to catch dirt. Simple and doubly protected plain enameled stretchers. A body is in place in the middle compartment. Contrast this with the average filthy refrigerator. (Courtesy of Oliver H. Bair's undertaking establishment.)

but if good carpenters and metal workers are available and one has time to give to the construction, much better results can be obtained. It should not be forgotten that a refrigerator can get very filthy, and that unless it is properly built it is extremely hard to clean it. Nor is filth the only real trouble. Time after time one hears of, and not rarely sees, bodies mutilated by rats and mice, more rarely by roaches, and occa-

sionally vermin have gone from one body to another. Such accidents can readily be prevented by having each compartment separated. I have in mind one of the largest and best equipped undertaking establishments in the country. After a fire they had temporary quarters in an old building infested with rats and mice and had plenty of serious trouble. In their present quarters they built a very simple but very perfect set of individual closets. The effect is so clean and attractive that simply to look at it shows its great advantage over the older forms, where foul odors, filth, and vermin penetrated the whole series of chambers. Their success has completely answered the question as to whether such construction is practical.

If I were to build a refrigerator it would have a frame support, a removable sheet-copper box, and a removable track which snugly fitted the bottom, and on which the truck holding the body ran. The truck should be of substantial construction, preferably of shellacked wood, with a shallow pan resting on the top. It should be on good rollers, and the head end should be at least 6 inches higher than the foot.

Usually it will be necessary to cool it with ice, and it is most desirable that some thought be given to the way ice is to be gotten into its place; too frequently this is forgotten and the results are very sad.

Great economy in ice can be had if the cells or compartments are separated by vertical partitions of wood, dividing the whole into groups of from two to four cells, depending on the average death-rate.

When the ice-box is being built a few small cells or compartments should be built for specimens and for children. Such cells should be at the end which is always supplied with ice. The reserve or emergency compartments being cut off, need not be cooled until the regular ones are nearly filled.

In small hospitals individual boxes, with separate ice-pans above, prove most satisfactory.

INSTRUMENTS

I conceive it will help not a few to be able to refer to a rather full, if not absolutely complete, list of tools and instruments that are useful in making postmortems.

I know such a descriptive list would have saved me many a weary hour and much hard labor. Nor have I yet completed my search for useful and practical instruments. I shall, therefore, give what may seem to be a very long list, and shall use the simple device of prefixing a star to indicate those which I regard as specially useful, and a double star to those that are necessary or best of their kind. The figures are chiefly made from instruments in my own collection, which I have thoroughly tried and found to have merit. They are selected from a rather large assortment. The arrangement into the various groups is in part arbitrary, but the divisions are simple. Many instruments are offered for sale and used by operators which do not appear because they are, for definite reasons, bad. To take up all the defects might be interesting, but would hardly be profitable.

In passing, we may call attention to the extremely unsatisfactory condition of the existing literature on the subject.

It would seem unnecessary to enter upon a discussion of the desirability of having all tools made of good materials, but, unfortunately, a large portion of postmortem tools are not only improperly shaped, but of poor materials. Every conceivable failure of construction can be found without seeking far.

Knives are either too brittle or too soft. Needles are made of a poor quality of granular metal and snap at the wrong time. Saws are often so soft that they will not stay sharp. Chisels chip and flake. Forceps bend. The price has very little to do with the quality. Learning to be a judge of the quality of tools is apt to be expensive and annoying.

Care of Tools and Instruments.—No good workman is above understanding his tools. The man who allows a second-class mechanic to grind his knives away to a mere tooth-pick, destroying the belly of the blade, makes a mistake which costs him more time and energy in a few years than if he started out in the right way by learning how tools should be cared for. Then he is independent of and capable of directing rather than being the slave and dupe of his grinders.

The fortunate operator who has a skilled assistant who relieves him of all thought regarding the condition of his instruments is to be envied.

All instruments should be cleaned with soap and water as soon as possible after being used. It is not necessary to coat them with oil or grease unless they are to be put away for a long time or in a damp place. The old way of smearing a lot of carbolated vaselin over knives should not be followed.

A little discoloration does no harm, but rust generally means neglect, and should always be avoided, or removed with care as soon as found.

Rough scouring is too often practised by assistants, and it generally injures the instrument. The roughest material I ever use is Hand Sapolio, and for ordinary cleaning a good silver polish, like Baker's, is the best thing to use. Emery is too coarse for instruments because it cuts fine grooves that increase the surface enormously, and this leads to easy rusting. Finely powdered Arkansas stone is valuable. Once a bit of steel is polished it will be found not to rust so easily, because the water can be wiped off and not left in the scratches.

The Knife.—One can become accustomed to any sort of instrument if it is absolutely necessary, and with excessive labor and care can become very expert in its use. There is, however, no real reason why it should be thought necessary to use the entirely unsuitable knives offered by so many dealers for postmortem purposes. Such knives are unwieldy, unsuited to the human hand at one end and human tissues at the other end. There are certain things that should be demanded in securing a knife:

(*a*) The handle must be large enough to fit the hand without too much effort in the usual manner of holding.

(*b*) The whole knife must be definitely fixed in relation to the hand by some notch or markings that will be easily found by the fingers.

FIG. 19.—**1. The best form of postmortem knife. *2. A good form of knife, made at my order before I obtained No. 1. *3. Large scalpel, made for me. *4, 5, 6, Scalpels out of my small dissecting case, showing very desirable shapes for finer work. 7. A fine probe-pointed knife, for use with fine director or in opening small vessels. *8. The best form for use with an ordinary grooved director. 9. A double-edged knife, most valuable in clearing small spaces. 10. Very small dissecting knife for finest work. 11. A good cheap knife. 12. Long, narrow-bladed knife for working in confined places. 13. Double-edged, long-handled knife, excellent for cutting nerve-roots. 14. Long knife curved on the flat, useful about the throat and spine. 15. Long-handled knife with short cutting edge, occasionally useful for dissecting deeply seated parts, such as orbit and pharynx. *16. Convenient form of scalpel, with good handle and blunt dissector on the end. 17, 18. Curved knives with different points. 19. Excellent form of coarse teasing knife, where the tissue is transfixed, hooked up, and cut with one stroke. 20. Needle knife for delicate teasing without traction. *21. Simple form of cheap slicing knife, for making sections of large organs. Inch scale is seen above; metric, below.

This tells at once to the trained hand just where the point is without the aid of the eye and without possible error.

(*c*) The whole knife should balance about the point of contact with the forefinger and tip of the thumb.

(*d*) The handle should be only long enough to fit the palm of the hand, and not project so as to be in the way or destroy the balance or interfere with work in confined spaces. What projects beyond the surface of the palm is never of use and only a hindrance, tending to injure the skill of the operator, and such instruments always remind me of trying to dance in wading boots.

(*e*) The blade should not be over 3 inches in length. I have used all lengths and have watched others work so often that I can, with full assurance, say that the use of the long blade is a great mistake, though it is a very common one.

(*f*) The blade should never be straight or sharpened to a fine point, but should have a well-rounded point (as shown in Fig. 19, 1, 2, 3). Most grinders will soon ruin a good knife if left to their own inclinations.

(*g*) The edge should not be too thin. A razor blade is only useful in a section knife. I get the best results when the blade is slightly hollow ground to about $\frac{1}{8}$ inch from the edge. This edge should have a V shape which should follow the whole blade from hilt to point. A knife of good hard steel that is hollow ground to the edge has so brittle an edge that it will not stand the rough cutting.

(*h*) The use of too sharp an edge is another common error. Let the edge be very smooth and absolutely without nicks, but never allow the grinder to put a razor-edge on it. Too keen an edge demands such constant care and such tense holding of the knife that the hand soon tires and the quality of the work falls off rapidly. It is like writing with an extremely fine pen on rough paper.

(*i*) The handle should have no sharp angles or rough places other than those grooves which definitely fix its position in the hand, and these fixing grooves should be arranged with regard to the manner of holding, so that there will be no uncertainty as to where the tip of the knife is at any time.

The mind of the operator should be at the tip of the knife if he is to develop skill.

This general rule, that all instruments of precision must be grasped at the same place each time, is so closely followed by persons who are skilful that it is surprising that it should be overlooked so often in postmortem work.

(*j*) The material of the blade should be a hard, fine-grain steel that will easily cut into a wire nail, but will not be so hard that it will turn a hard file. I have had all sorts of knives furnished by dealers, some of which were soft, but more were coarsely granular and some far too hard. If the steel is too hard it will require frequent and useless grinding that will soon destroy the shape. I, therefore, choose one that will just yield to a fine-grained grit stone, such as Pike makes for pocket knives (shown in Fig. 32, 8). The material of the handle is of minor importance. The metal handle is perhaps the best, though a hard, close-grained wood is not objectionable, provided there are no bad spots in it.

Scalpels for fine dissection should be kept in a protecting case and should be sharper than the working knife. There should be definite markings that will insure the proper position in the hand. At least three sorts are desirable: one with a belly or curved cutting edge; one with a nearly straight edge and fine point; one with a blunt point (Fig. 19 shows several of these).

Bistouries are useful for nice dissections. Curved, with sharp points, they serve well with grooved directors in opening vessels and similar work. Curved, with fine probe points, they are occasionally useful in following a vessel. I prefer them to scissors.

Special Knives.—Long knives, with edges extending for different distances from the end, and those with blades curved on the flat and those with rounded points, all find their place in special work, particularly about the head.

Section knives of various types are recommended. They are useful in demonstration work before classes. Their use is not to be so freely indulged in as has been the habit in the past. Dissection is better than slicing, except when such work is done for microscopic study or in the preparation of museum specimens. They should form part of the equipment of mortuaries, and should not be marked as measures, but be very smooth and sharp.

Shop Knives.—I have found certain forms of butcher knives useful at times. We will be wise if we use suitable instruments, no matter who adopted them or invented them.

Razors are rarely needed in their ordinary form, but those that are ground flat on one side are very useful in making free-hand sections. Fig. 32, 5, 6, show the usual types, one being for cutting in a direction from the body, the other for cutting toward the body. All section knives are used wet (see Fig. 61).

The Manner of Holding a Knife.—The human hand and its component parts form part of a machine which is capable of enormously variable exercise, but no one conceives that such variableness of the hand warrants a billiard player in holding his cue in any but the right way. The expert penman is equally oblivious to the freedom of motion of the arm and hand when he selects a very definite pen hold. The surgeon and the postmortem operator too often imagine that holding a knife comes by some instinct, while they take lessons in holding a golf stick. I must confess that the results affect me as my holding of a golf stick would an expert in that line of endeavor.

The cutting or ordinary knife should be grasped in the hand so that the point is nearly in the axis of the radius. The end of the thumb opposing the second phalanx of the index-finger is at a fixed part of the handle. The handle of the knife may assume one of several positions in the palm, depending on the sort of cut to be made:

(*a*) For heavy cutting, in a downward direction, it is close to the base of the thumb.

(*b*) For free wrist cutting, in a side direction, it is grasped by the other fingers.

This is varied slightly in scraping or "feathering," or for that most useful motion for which no received name is common in which the knife is made to vibrate through a short distance with a firm hold and steady, directed progress. The pump-handle hold, where the knife is grasped without point of fixation or means of directing its axis by the fingers, is often used and recommended. It is entirely wrong and bad, and comes

Fig. 20.

Fig. 21.

Figs. 20, 21.—Manner of Holding the Knife: Full Grasp.

From the palmar or under side (Fig. 20); from the dorsal or upper side (Fig. 21). The thumb and forefinger fix the knife in position, resting in the two opposite grooves of the handle. The remaining fingers press the end of the handle well into the hollow of the palm. The wrist-joint should be completely without strain and midway between flexion and extension, as well as the extremes of lateral motion. This position should be entirely without strain, and is assumed from that of complete relaxation by the least possible effort.

from a country where the use of the knife in the dining-room and laboratory is certainly not artistic. The forefinger should not be placed against the blade of the knife except in heavy downward cutting and when the scalpel is held as a pen, but even then the finger is on the handle of the instrument.

The scalpel is held either as a pen, between the thumb and index- and middle finger, or between the thumb and index-finger, with the

handle either free or steadied by the other fingers, but should not be grasped in the hand.

The **use of the arm, wrist, or fingers in cutting** depends on the sort of work to be done. The fingers do most of the work in scalpel dissection, the wrist and arm being fixed. With larger knives the wrist and arm assume a much larger share in the motions, and the fingers become

FIG. 22 shows the full grasp as in actual hard cutting. The thumb and fingers close firmly on the handle. The wrist is bent to the ulnar side so that the axis of the knife is parallel with that of forearm, which directs the cut. This is the position assumed in all forceful cutting, as in making the primary cut in opening the body. One does not maintain this position except during actual cutting, but relaxes into the full grasp.

FIG. 23 shows a freer hold, where the cutting is done with the wrist and the knife is fixed by the thumb and forefinger. The other fingers are relaxed, but are always ready to contract and resume the full grasp. The relaxation of the tendons of the fingers gives great freedom with corresponding ease. The background is ruled in inch squares.

fixed except in making very short cuts. With the ordinary knife the arm becomes the chief source of motion, either in up or down or side cutting, as well as in all vibratory or eraser-like movements, the hand fixing the knife, the wrist giving direction and changing direction during the cutting when necessary. The wrist, however, is the source of a number of separate cuts where the line is to be a curve of short radius and in working about in confined places.

It will be clear, on thought and practice, that the fingers, wrist, and arm must be so controlled that they will work in harmony of action or

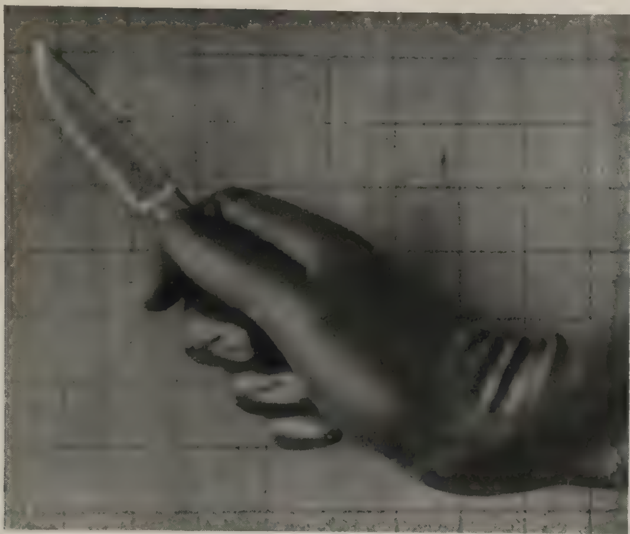

FIG. 24.

FIG. 25.

FIGS. 24, 25.—THESE SHOW THE WRIST ACTION WITH FULL GRASP.

Fig. 24 shows the beginning of the stroke.

Fig. 25 shows the finish. This wrist stroke is very useful in quick, determined work in limited spaces, as in freeing the organs and separating flaps.

fixation, so that every possible degree of motion and every possible position and direction of the knife can be perfectly secured. Any

instructions that direct the use of less than all of them cannot possibly be good.

Scissors should have comfortable oval finger loops, and the blades should be separable. I use a long-handled pair most, and these only occasionally, chiefly for removing the pelvic viscera in a single mass. The fine-pointed type are but rarely of use, and the danger attached to their use is not inconsiderable; except for the finest dissections I do not

Fig. 26.

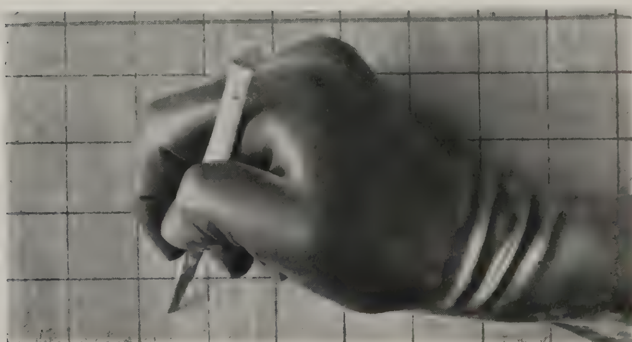

Fig. 27.

Figs. 26, 27.—The Pen Hold of the Scalpel.

The handle is fixed between the thumb and middle finger, which is a little lower. The forefinger rests on the top with gentle pressure and directs the stroke and determines the pressure exerted on the blade. The free part of the handle rests against and glides over the base of the forefinger.

Fig. 26 shows the position without tension.

Fig. 27 shows the position at the end of a full 3-inch stroke with the fingers flexed and the wrist bent backward. Usually the best results are obtained with a shorter stroke. This is by far the best general hold for fine dissection.

advise them. I am convinced that scissors are too often used because the skilful use of the knife has not been attained.

The knife will open the hollow viscera quite as well, but there is no objection to using scissors if one will but realize the effects they have on tissues. The common practice of snipping away tissue about some organ or part is generally bad practice because it leaves a ragged surface unless most carefully done, when it becomes tedious, but is at times

FIG. 28.

FIG. 29.

FIG. 30.

FIG. 31.

FIGS. 28–31.—THE VARIOUS SCALPEL HOLDS.

FIG. 28.—The firm hand hold for wrist and arm action, for side and upward cuts and for long cuts. Gives great freedom and is a relief after prolonged use of the pen hold.

FIG. 29.—The same hold with the hand rotated to show the position of the fingers; being practically the same as the full grasp hold for the knife.

FIG. 30.—The pen hold, side view.

FIG. 31.—The thumb and finger hold for light, free, rapid work. Gives great latitude of movement. Specially for cuts parallel to the horizon.

necessary. The shaving motion of a knife gives cleaner and more satisfactory results, is easier and much quicker, for one has to be very expert with the scissors to follow the varying curves, while the knife traces along in any direction with ease and precision. Another great

FIG. 32.—**1. Long-bladed scissors. **2, 3, 4. Medium-sized stout scissors of slightly different forms—all have separable blades. 5. Section razor, ground flat on one side for cutting away from body. 6. For cutting toward body. 7. Budder's knife, a very convenient form which by folding protects the blade; the handle is tapered almost to a sharp edge and forms an excellent blunt dissector. **8. Pike penknife whetstone—light, cheap, convenient, of good quality and suitable grit, to be carried in bag. **9, 10. Different views of the best form of needle. *11. Convenient form of high-power pocket lens. 12. Knot of string (see Fig. 48).

disadvantage is that one point of a pair of scissors has to be down in the tissues, and is too often ahead of the dissection and does damage or delays the work. Fine dissection should have more of fine carving and resemble drawing, with little snipping.

At times the scissors are better than a knife. This is specially true

in cutting flat tissues where both sides are free, and where pinching is not objectionable, or even may be desirable to check oozing from small vessels, as in the diaphragm, the omentum, the intestines, or any delicate structure that is to be cut without risking traction.

They are also of advantage in cutting in the dark, as in the removal of the organs of the throat from the thorax, where the high neck cut is not permitted. In such cases the long scissors are directed by the forefinger of the other hand.

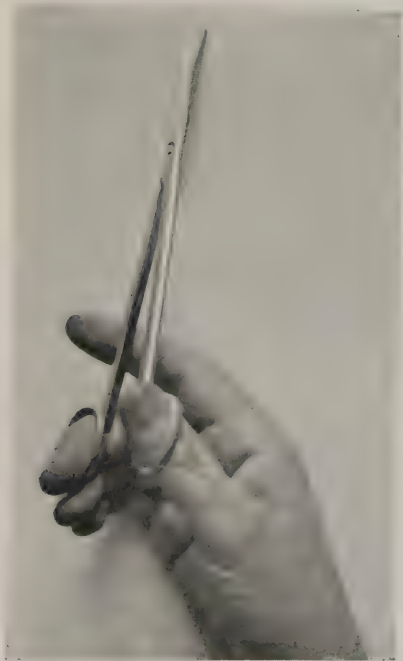

FIG. 33.

FIG. 34.

FIGS. 33, 34.—THE USE OF THE SCISSORS.

Fig. 33 shows the long-handled form, from the side.

Fig. 34 shows the short or ordinary dissecting form, turned to show the palmar view.

These show how the thumb naturally opposes the middle finger and how the index-finger guides the blades (and how the law that three points determine a plane is applied to holding of instruments). If the configuration of the hand demands it, the ring finger may be used. This will depress the point, so that in certain forms of snipping it is desirable. Generally the middle finger has greater mobility than the ring-finger, which is very important.

Blunt dissection, either with the fingers or some pushing instrument specially devised, or oftener with the edge of the ordinary knife held at nearly a right angle to the surface and used nearly at the same angle to the direction in which progress is to be made. (Fig. 35, 6, shows a useful tool for heavy work.)

Shears of various sorts have been devised for every conceivable sort of work. Many of them can be entirely overlooked without serious detriment.

Cartilage shears can generally be reserved for the well-equipped mortuary or dissecting room, as a good knife will generally do all that can be done with shears, and a saw can be made to do the rest. There is an advantage in resting the hand at times by changing instruments, but shears are apt to require a degree of force which disturbs the fine

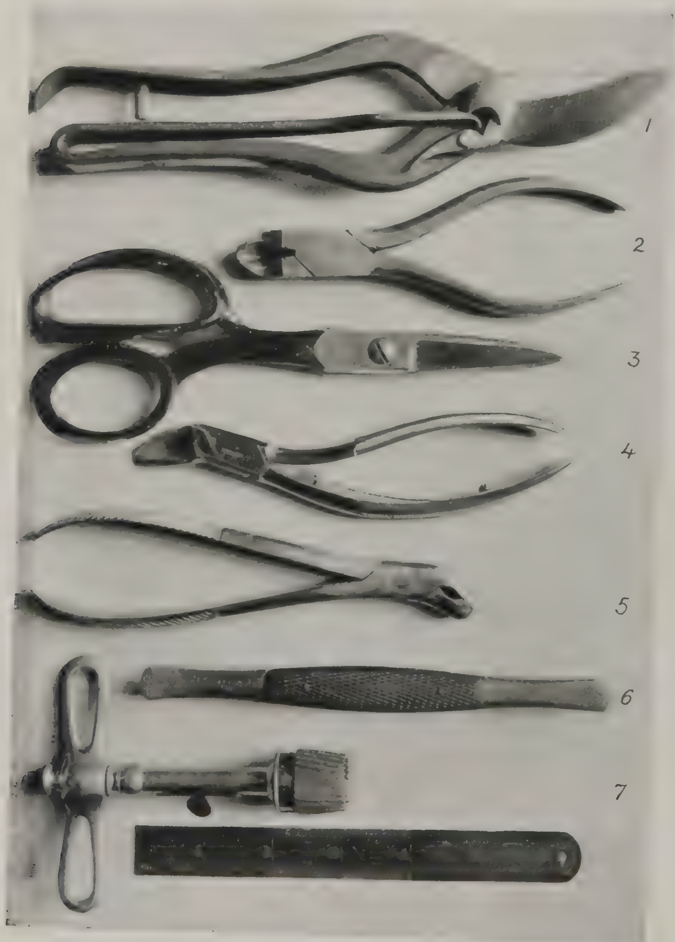

FIG. 35.—FOR BONE WORK.

*1. French form of pruning shears, with simple clean mechanism—cheap, strong, of good shape—best form of rib cutter I have yet seen. 2. Wire cutters with jaws set at angle, excellent for trimming away bone edges. *3. Stout shears, indispensable in the laboratory. 4. Swiss form of bone forceps, perfect for fine work. 5. The best form of Rongeur forceps. *6. Excellent tool for periosteum and bone work. 7. Trephine, sometimes useful in head work. The inch scale is seen below, a bit of the metric scale on the left.

adjustment and sensitiveness of the hand, specially if used when a saw should be used. For cutting the sternum out a curved pair of shears has the advantage that the small blade can be pushed in carefully and close to the wall, thus avoiding the underlying structures. Generally they are too clumsily used as well as too frequently.

FIG. 36.—SAWS AND BONE CUTTERS.

1. Common form of bone cutter, occasionally useful. 2. Special form for use about the spine, occasionally of value. 3. Rib shears, an expensive imitation of pruning shears and inferior to the pattern shown in Fig. 35, 1. 4. A good form of single saw for the spine, made out of a carpenter's "back saw." 5. Double-bladed saw for opening spinal canal. Note the various adjustments and numerous places for filth to collect.

Bone forceps are of use in special dissection where the bone is brittle and the chisel is apt to shatter the bone, though this is not often the case because equal care will give better results with the chisel, and it is not

always easy to secure working space for forceps either for jaws or handles (Figs. 35, 36).

Trephines with a handle or attached to a brace are convenient in rare cases. So rarely are they of use that one can save considerable expense and attain at least as good results by getting a few reamer bits and a cheap brace. (See Fig. 35, 7; Fig. 51, 1, 2, 3.)

Fig. 37.—*1. An excellent straight saw, with the most desirable form of handle, well backed. *2. A common type of curved saw, good for general work. 3. Small flexible saw, often of value in confined spaces. 4. Small partly backed saw, more easily used than No. 3. 5. Small curved saw for getting into small places (would be better if the teeth were set in the opposite direction).

Spine cutters, for shearing the laminæ of the vertebræ, can be used in children, but for adult work the jaws have to be so heavy and the force used so great that the risk of injuring the soft tissues is too great.

Saws have been a fertile field for those who have mechanical pride, because any one can devise a new saw with a minimum of skill. A

general saw for a handbag should be curved so as to be usable for taking out the spinal cord. It should have a good stiff back, an easy handle, and should be about 12 inches long. (See Fig. 37, 2, for a fair sample.)

FIG. 38.—*1. A large butcher's knife with slight curve and peculiar shape, fairly rigid, good handle; the *best* knife for sectioning large organs. 2. A handy keyhole saw. 3. Fine cut "back saw" for fine bone work, with a very useful universal handle. **4. Carpenter's "back saw" with 12-inch blade. The best saw for opening the skull. The background is a bread board ruled in inch squares with waterproof carbon ink, then well shellacked.

For opening the head there is no better saw made than a good carpenter's "back-saw," with a blade 12 to 14 inches long (Fig. 38, 4).

The butcher's saw with a frame and a narrow blade has the decided disadvantage of bending too freely.

Small saws are generally so badly devised that their use cannot be recommended. Most of them are too flimsy, allowing bending, which makes the work difficult. Keyhole saws, so often recommended, require too much space for the point to work in and can do great damage to tissues.

Spine saws, either single or double bladed, are desirable in the operating room. Fig. 36, 4, 5, show two good types in use at the Philadelphia General Hospital. The double-bladed form is supposed to save time, but this depends on the skill of the user. My own preference is for the single blade.

Use of Saws.—The chief trouble a beginner has is to drive the blade in a straight line, the tendency being for the hand to describe an arc of a circle, which causes the saw to bind and jump out of the cut. This can, in a measure, be overcome by sawing in a plane nearly parallel to the front of the operator's body, turning the body so that the side of the free hand is toward the object being cut.

The saw should be so firmly grasped that it would not slip more than a small fraction of an inch should it leave the cut. This requires considerable muscular effort, for there is a considerable expenditure of energy in thus opposing two sets of muscles, and necessitates frequent brief rests to maintain accurate control. Improperly filed or set saws will choke quickly. This occurs more often with those made by instrument makers than in saws made for real mechanics, such as carpenters or butchers.

If one has to finish a piece of cutting with such a saw frequent wetting and wiping on a coarse cloth, drawing the saw at right angles to the surface of the blade, will help materially. The saw must not be crowded too hard into the bone. One can acquire skill only by patience and care and by observing the rules given. Control can be gained by going through the motion free hand without an object in contact with the saw. This can then be improved by sliding the back of the saw over the finger of the other hand, using it in all directions.

Chisels.—The art of carving bone is not an easy one to acquire, but it fortunately is only needed for special dissections. The unfortunate part of it is, that when the necessity arises it is very urgent, and one has no time to learn, and one cannot afford to bungle.

There are two sorts of chiseling—bone chipping and cutting. Chipping should be done with small chisels, such as can best be gotten from a good hardware shop (Fig. 42, 2, 3), or made from fine tool steel (Figs. 39, 5, 6, 7, 8, 9), and the hammer, either of steel or brass, should be a mechanic's tool. I have not yet seen a suitable hammer made by an instrument maker, though I have examined hundreds.

Large chips may be cut off with carpenters' chisels (see Fig. 41, 1, 2, 3), or surgical instruments (Figs. 39, 40), using mallets of wood or rawhide, which give their momentum up more slowly than metal ones. Fine cutting requires an adjustment of the size of the cutting edge, the

weight and elasticity of the hammer, and the sort of blow to the sort of bone to be cut. Sharp blows with metal hammers on small cutting edges are less liable to produce undesirable fractures. The use of a

FIG. 39.—1. Chisel with edge on side, small point projecting at end (this has since broken in service as in No. 2, from too high granular steel); advantages, easily cleaned, no sharp edges about handle or back. 2. Similar side-edge chisel, broken in service (granular steel); shows particularly bad method of roughening handle; the shape, however, is much better than No. 1. 3. A useful form of chisel, but too large for general work. **4. A most useful chisel; note shape of handle, fine transverse ribs, rounded end. *5, 6, 7, 8, 9. Five home-made chisels, excellent for bone work, made of tool steel. *10. Grafter's tool, a good chisel and hook for calvaria or general bone cutting. *11. Universal tool-holder supplied by makers of dental instruments. 12, 13, 14, 15, 16. Five dental tools which I find exceedingly useful in fine bone dissection. *17. The most useful tool for cleaning the surface of hollows in bone, such as the interior of the cranial and facial sinuses. 12, 16. Useful, but have the disadvantage of unscrewing if one exerts any force on the blade.

chisel to open the partly sawed skull-cap is so bad a practice that it cannot be too severely criticized, because artifacts are apt to be produced that are misleading, and there is no necessity if the saw is properly used.

Postmortem chisels are generally made and devised by persons wholly ignorant of the art of using them, and are generally very poor. No chisel should have any sharp angles where either the hand or the hammer contacts are made. Chisels may often be used with advantage as levers. This is often necessary in working about the skull after the chipping and cutting has loosened blocks of bone that are to be removed.

Spine chiseling was at one time far too frequently resorted to, but at present the reaction has gone too far. A stout chisel with the edge

Fig. 40.—1. An unusual form of side-edge chisel that is lighter and has a better handle than those commonly found. 2. This instrument is so bad in every particular that it deserves notice. 3. The head of this hammer is excellent, the handle is too small and not properly shaped, and the hook is a most undesirable feature on a hammer, but the instrument is very good as a hook because the head of the hammer forms an excellent handle and the hook is properly shaped; it is the best hammer and hook combination I have yet seen. 4, 5. Useful types of medium-sized chisels. 6. A large, long needle for sewing up body. This type is preferred by several very competent morgue attendants who always use the "baseball" stitch. It is not as satisfactory for the invisible stitch.

on one side and a small point at the end (Fig. 39, 1) is often of great use in opening the spinal canal, specially when the saw has been used to partly cut the laminæ.

In the upper cervical region and in the lumbar curve, where the saw does not go readily, the sharp blow of a metal hammer on a side-edge, wedge-shaped chisel helps wonderfully.

If one cannot modulate the blow and direct the hammer correctly, but must jerk and slam, it would be far better to entirely eliminate the hammer and chisel from the outfit.

Faults of chisels are so common and so serious that one often has to search a long time before one can find a good tool even among mechanics' supply stores. Generally the steel is granular and too hard.

FIG. 41.—1, 2, 3. Three carpenters' chisels, which have the advantages of being long enough to reach the spot, still giving free view, having proper handles. 4. Riveting hammer of steel, good for fine bone work. *5. Best form of wooden mallet, the head will not come off and the handle is flattened. 6. Rawhide mallet, seldom used, but good to have in a completely fitted mortuary. *7. Large sized brass headed machinist's hammer. 8. Carpenter's gouge for bone work. These tools can be had at any good hardware shop; are cheaper and better than those generally used. The background is ruled in inch squares.

Hammers.—The best single hammer is the mechanic's brass, square-faced one with a good round handle. For the well-equipped room one

may add a stout wooden mallet, with the handle inserted so that the head cannot come off (Fig. 41, 5); a medium-sized rawhide mallet (Fig. 41, 6); one or more brass hammers, such as mechanics use (Fig. 41, 7; Fig. 43, 1, 2). Fancy hammers are seldom satisfactory, and the hook which is placed at the end of the handle is entirely bad.

The rounding of the face is another common mistake for which I have never found an excuse, as the skill required with the best hammer is sufficiently taxing without any such handicap. Square postmortem hammers with sharp angles are commonly offered for sale and too frequently used.

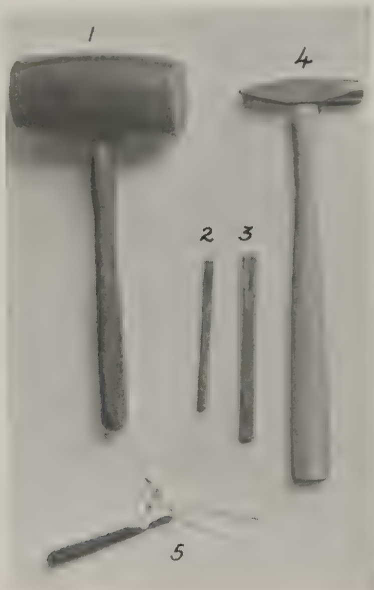

FIG. 42.—1. Common form of wooden mallet having two defects: (*a*) head not securely fastened and liable to fly off; (*b*) handle small and round so that it does not inform the hand where the striking face is. *2, 3. Two useful mechanics' chisels. 4. Riveting hammer, the edge can be ground sharp and used as a chisel. 5. Septum calipers, useful for measuring thickness of objects deeply seated.

Long handles, sharp edges, rounded striking surfaces, roughened surfaces where shaping should be used to help the hand to hold on, and all similar errors should be avoided. In using the hammer one has greatest control when the elbow is near the side and the forearm moves in simple extension and flexion, the wrist being generally fixed and the thumb-nail looking away from the object being hit. The thumb should be parallel to and rest on the handle.

Rectractors.—While dissecting one is constantly needing some method of properly fixing either the parts being cut or parts adjacent to them. The hand is in constant use for such purposes, but it is too large for nice work, and hundreds of devices have been gotten up to relieve it. The very best retractor is a bit of twine with a small sailmaker's needle. The method of using this is to be seen in the various

FIG. 43.—1. Small brass mechanic's hammer. **2. Medium-sized, same type. Note sensible shape of handle and rivets in head and handle. 3. A typical instrument maker's hammer, breaking down in service at the joints and on the striking surface. *4. The best form of instrument maker's hammer yet found, has had long, hard service in my kit, the rounded part of the head is of use in percussion of bones, specially of the skull; the head is of soft metal, the handle is too smooth and not well shaped, though the oval shape of transverse section is a good feature. *5. A very useful little dissecting case which I have carried for fifteen years. The instruments are all good and are shown separately. It has already been shown in another work on postmortems. It is compact, strong, clean, and preserves the instruments. *6. Small vest-pocket electric lamp, very useful, specially in house-to-house work. 7, 8. Two paper cones for measuring opening or holes, bullet wounds, etc., made of 3- by 5-inch note cards. Scales in margin.

figures of dissections. Cheap picture hooks and a loop of twine, as shown in Fig. 44, 5, 6, are very useful. Where assistants are capable and at hand various forms of hooks, such as are shown in Fig. 44, are of use, as well as for individual dissection without assistants.

Fig. 44.—1. Useful form of retractor if one has an assistant. 2 affords a clear view without obstructing the work. 3. Simple tongue depressor, useful in observing mouth; can be held in the hand or anchored. **4. Retractor and forceps, can be held or anchored. **5, 6. Two common brass picture hooks with loops of twine; the simplest and one of the most useful forms of retractors. *7. Hemostat with catch, for dissection, retraction, or clamping vessels. 8. Single hook, for fine work. 9. Double hook. *10. Blunt hook. 11–16. Different useful hooks. *17. Aneurysm needle with eye.

Various forceps, such as are shown in Fig. 45, are really necessary.

Whatever device is used, care must be exercised to avoid injury by sharp points, too great compression, too great traction, ripping out because sufficient hold has not been taken or wrong instruments have been selected.

So far as possible, simple, cleanable tools should be selected which do not require excessive force at the same time that delicacy of action is required. The combination of retractors and twine, with either weights or screws to hold the other end, will yield the best results.

Roller bandages can be used for large masses.

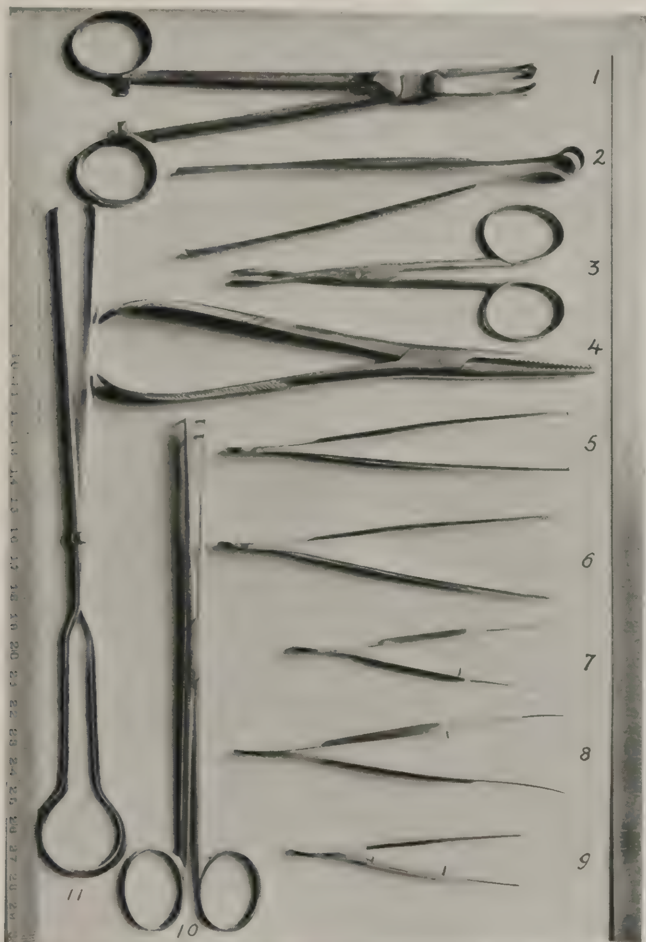

FIG. 45.—**1. The most valuable form of general dissecting forceps, has separable blades, blunt saw-tooth grasping surfaces. **2. The most satisfactory form of the ordinary dissecting forceps, procured from Haertel of Breslau; the spring is light, being made of one piece of metal, is easy to clean, has several rat-tooth points which accurately interlock. 3. Scissors form or hemostat, without catch. **4. Sequestrum forceps, extremely useful. 5, 6, 7, 8, 9. Various forms and sizes of dissecting forceps for finer work. 10. A convenient form of retractor. 11. Cheap sponge-holder, simple, clean, useful, light, strong; an excellent retractor.

Forceps.—The ordinary forceps found in the shops have many faults, which are to be avoided as far as possible:

(1) They are too firm, requiring too much force to hold.

(2) The teeth are too few and too sharp.

(3) The side motion is so great that the teeth do not properly oppose when closed. The use of instruments with rather long edges

FIG. 46.—PROBES AND SOUNDS.

**1. Stiff sound, graduated on one side in centimeters, on other in inches. *2. Flexible sound probe—in 1 and 2 the handle is ribbed on one side only. *3. Large hard-rubber sound, rigid. *4. Curved hard-rubber probe, flexible. *5. Fine long filiform probe. **6. Stiff metal probe; note lower end which is flat and ground in a peculiar curve, very valuable. **7, 8. Filiform celluloid probes. *9, 10. Hog bristles. 11. Flexible metal probe with searcher. 12. Steel knitting-needle with well-finished ends. *13. Stiff long metal probe with eye in lower end. *14. Grooved director with curved end, should not be of too soft material. 15. Flexible metal probe without bulb, one end is flattened. 16, 17. Short probes of aluminum wire, one end is turned blunt, the other is sharpened; easily made and extremely useful. 18, 19. Very flexible whalebone probes with very slightly bulbed points. **20. Soft-metal probe with hard-rubber handle which is well shaped. *21. Double-ended grooved director. Note the taper of the ends, also the angular offset which allows one to work and still see one's work. Scales on either side.

composed of saw-toothed surfaces are better for general work, but for fine work one must have regular dissecting forceps. Fig. 45, 5–9, shows

some of the better types. Fig. 45, 4, is extremely useful, and is mentioned throughout the text as sequestrum forceps.

Probes.—The finger often fails us, though it is the great and general probe. In Fig. 46 I have given a selection of the forms I have found specially valuable. All probing must be done carefully, with a full realization of what damage can be done by careless work.

Flexible probes are generally needed only in small sizes, but rubber catheters may be useful at times. Bendable probes should always have some mark or device, so that the direction of the opening in which the probe lies can be told. Measuring probes and sounds of various forms are convenient for an elaborate workshop, but are not necessary.

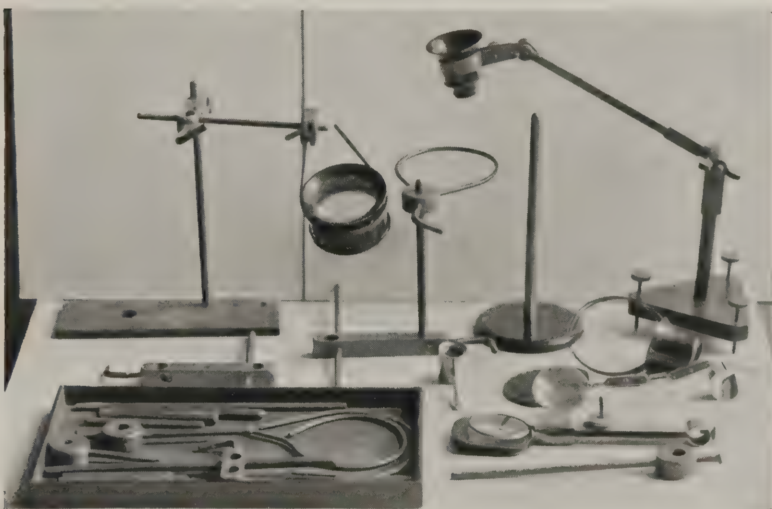

Fig. 47.—A Number of Simple Devices for Holding Lenses.

In all fine dissecting one wants a low-power lens, and that on a stand. In the tray are seen a number of pieces of springy brass wire. These have one end cut with a screw thread to fit holes in bits of brass that slide on standards. Above is seen an engraver's glass held in a built-up stand. The extreme simplicity of the unit system gives any desired position. On the right is seen a holder I had built, with a watchmaker's glass—more elaborate and costly and inferior to the system I developed later. Other lenses of desirable forms are shown. Note specially the metal buret clamp and the jointed lens-holder that fits on the finger.

Fig. 46, 1, shows a measuring sound graduated in inches and centimeters that is light, useful, and thoroughly practical. Fig. 52, 12, shows the other side of the same sound.

Blowpipes have been recommended, but their use is very limited in human anatomy except in rare cases of fine work, and the manner of using is hardly up to modern standards of sanitary methods. For laboratory work I much prefer a glass canula attached to an atomizer bulb or to a rubber tube attached to a funnel or syphon in which is placed water. I will not carry a blowpipe in my bag because I regard its use as nasty and not necessary.

Lenses.—At times it is not only desirable but necessary to use mod-

erate magnifiers. The ordinary pocket forms will do, but care should be taken to secure one which gives a large flat field. The watchmakers' glasses which have a spring attached are very useful. It is not necessary to have elaborate or expensive holders or dissecting microscopes, as simple clamps on brass rods, such as are shown in Fig. 47, are sufficient. (See Fig. 32, 11.)

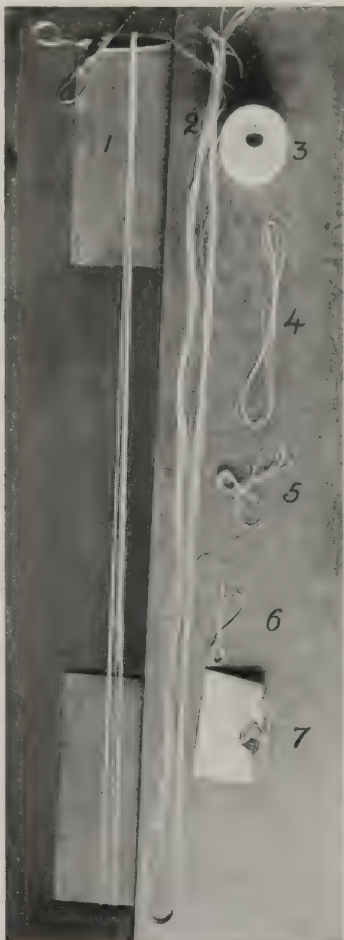

Fig. 48.—1 shows how the twine is wound over the sliding shelves of an ordinary desk; it is then cut with shears. 2. A cut lot ready for looping. 3. Ball of gill-net twine. 4. One loop three times folded. 5, 6. Manner of making a slip-knot with ends of different lengths, so that by pulling these ends the knot is easily slipped. 7. A common envelope holding a dozen such loops.

For Repairing the Body.—*Twine.*—Good quality linen thread, such as is sold for gill-net, of about four strands. I find it a great convenience to prepare a quantity of knots, slip a handful of these into an envelope, and thus avoid having tangled string in my bag. Fig. 48 shows

the manner of preparation. The lengths are about 8 feet long, which gives about the right amount for a head or body when used double. By slipping an envelopeful of these knots into the side pocket of the bag one has no twine troubles, such as are sure to accompany any other method I have yet heard of.

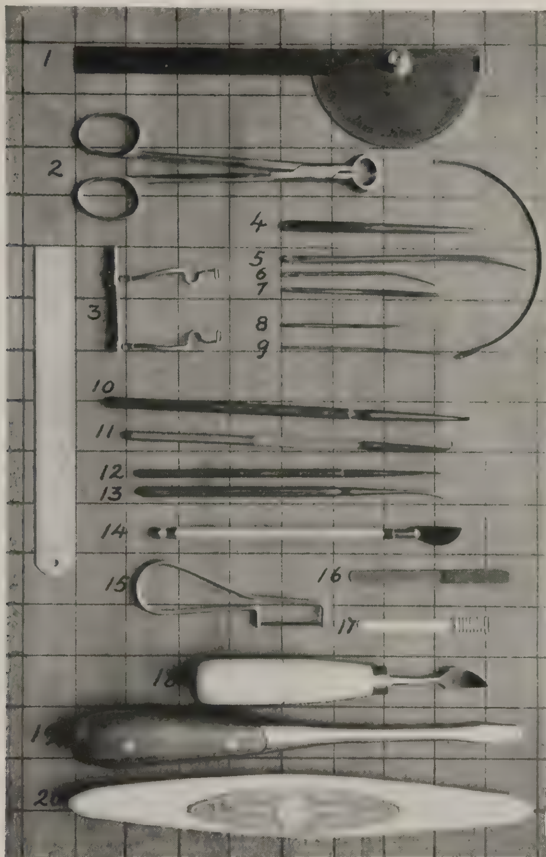

FIG. 49.—1. Protractor for determining angles accurately. 2. Useful retractor forceps for holding large masses. 3. Eyelid retractors, also useful in other dissections. *4–9. Various forms of needles. 10–13. Useful dental tools. 10 has a short stout cutting edge, for bone work. 11. A very stout little hook. 12. A sharp-pointed drill. 13. Tapering tool of soft iron, easily bent into desired curves and angles. 14, 15, 16, 17. Fine dental saws for bone work. 18. A dental scraper, excellent bone tool. *19. Stout screw driver, useful as chisel, wedge, or elevator in coarse bone work. *20. Cheap whetstone with firm moderately coarse grit to supplement the fine-grained hones. Combined centimeter and inch scale on left. Background 1-inch squares.

For the postmortem room the ball should be suspended and a guarded knife edge fixed conveniently for cutting. Filthy twine is inexcusable, but not rare.

Needles are too often made of bad steel and break without due cause. For years I have used a double-curved needle, made of high-grade drawn tool steel with moderate temper (Fig. 32, 9, 10), and I have never

had one break in use. It is $5\frac{1}{2}$ inches long. At one end the section is a flat triangle with a base of $\frac{3}{16}$ inch. The eye is a clean, long oval and the edges are rounded so that they do not cut the string. There are grooves on both the upper and the lower surfaces for the twine to fit in, so that there is no catching when the eye enters the opening in the tissues. The needle should not be ground, but may be sharpened on the edge of the hone or by using a fine file, or, in emergency, the knife can be used as a steel. The temper of the needle being much lower than that of the knife, no harm is done to the blade. In Fig. 40, 6, is shown a fair type of needle that attendants seem to prefer because of its large size.

Sailmakers' needles of various sorts can be used, but I do not find the straight form of use except in dissecting (Fig. 49, 4–9). Small surgeons' needles for repairing wounds or small cuts are necessary, and are placed with white silk in a small envelope and carried in the side pocket of the bag.

Weights and Measures.—*Length.*—One has such a variety to choose from, and each type has its own advantages, that one accumulates a large collection of all sorts of measures. For the bag the small spring tape, either of steel or enameled cloth, with markings in inches on one side and in centimeters on the other and two meters long, is by far the most satisfactory type (Fig. 50, 11).

For the postmortem room one requires several sorts:

(1) A long pine strip, about 1 inch square and 7 feet long, marked in inches and centimeters, and well shellacked for total body length.

(2) A yard or meter stick of wood with brass tips.

(3) A folding brass rule (Fig. 51, 5).

(4) A spring tape for circumferences.

(5) A measuring probe or sound.

To these may be added such other forms as may be desired for convenience or for greater minuteness. Figs. 50, 51, 52 show some useful patterns.

Calipers are often useful, and a great assortment of these can be found in any good tool shop.

I find the use of the square-ruled dissecting board, shown in Fig. 49, a great convenience, because it constantly shows the size without handling a measure, and gives an excellent idea of the elasticity of the organs as they settle when laid on it. Ruled plates of glass, both in the study of tissues and photographs (see Figs. 53, 54), are very valuable.

Circular measures, for taking the diameters or axes of cavities, holes, or curved parts, are sometimes necessary.

For small openings various forms of cones have been devised. Fig. 50 shows types of cones frequently used. These forms give the total circumference rather than the true diameter, and a set can be kept in the postmortem room if desired, but their use has been carried to an absurd point in the past. A simple substitute can readily be made from a library card, as shown in Fig. 43. For measuring wounds this is much better, because the angle of the cone can be adjusted to the size of the wound, and the point entering the wound is less likely to disturb

FIG. 50.—1, 2, 3. Flat steel "cones" for measuring openings. 4. Small micrometer for accurate measurements. *5. Very convenient calipers for measuring diameters, thickness, or distances. 6. Common form of cone for openings. 7. Very accurate micrometer for thickness (bullets, etc.). 8. Convenient form of boxwood rule. *9. Standard flat steel measure. *10. Convenient form of light folding rule. **11. Enameled cloth tape measure *12. Steel tape; good, but apt to rust. *13. Flexible standard steel measure for curved surfaces.

the deeper tissues. This card can be dried, treated with formaldehyd, and kept as a permanent record. It has the added advantage that in oval wounds or holes it gives a more accurate measure of the circum-

Fig. 51.—1. Cheap brace, with handle removed to prevent collection of filth, makes trephining easy. 2, 3. Two bits, cheaper and better than ordinary trephines. *4. Butcher's carborundum sharpener, indispensable in the mortuary; has a moderately coarse grit which cuts into the knife, the finer hone giving the desired edge afterward. *5. Horseshoer's brass folding rule—cheap, strong, and entirely satisfactory. *6. Large mechanic's calipers, far better and cheaper than those devised by instrument makers. The background is a bread board ruled for angles and shellacked.

ference than a rigid cone, and the measurement can be made with great accuracy by nicking the exact point to which the cone has entered with the knife. For accurate work it is well to pin the cone in shape.

FIG. 52.—*1. Esthesiometer with scale, useful for quickly measuring distances, specially on uneven surfaces. 2. A convenient form of calipers. 3. Map measure for taking off the length of irregular lines, such as the contour of skin lesions. *4. Cheap but very useful dividers, with thumb-screw setting attachment. 5, 6, 7. Useful thermometers: 5, for surface temperature; 6, quick acting, does not register; 7, "clinical." 8. Accurate micrometer, the small thumb ratchet insures an even pressure on the object, which is of vital importance in measuring soft objects. 9. Metal frame holding ruled glass, one set is ruled in 0.5 cm. squares (see Figs. 53, 54), the other in radiating lines to give the angles; very useful in studying objects and photographs. 10. Standard metric rule of wood, 30 cm. long, seen in nearly all the instrument figures. 11. Calipers I had made for studying skulls, the advantage of the scale is that one can directly measure between points that are sunk below the surface. 12. Graduated sound for determining depth.

Angles can generally be estimated with sufficient accuracy, but some form of protractor should be kept in every postmortem room (see Fig. 49).

Fig. 53.—Showing How Convenient Ruled Glass is for the Study of Photographs or Objects.

In this case the glass was laid over the negative in the printing frame. It enables one to quickly estimate the size, shape, and direction of injuries or lesions.

Fig. 54 Shows Hole in Skull, from Same Case as Fig. 53.
The man was beaten to death with a hammer.

For hasty work without an instrument a piece of paper can be folded, and later the angle measured, by holding the paper so that the edge is in the same direction as one side of the angle to be measured, and by rolling the opposite edge between the thumb and forefinger it can be brought accurately to correspond with the other side of the angle, then by simply pinching this rolled edge we have a record of the angle for careful measurement.

Square surface measurement of irregular bodies is always difficult. For this work I find the dissecting board with square ruling is good for flat objects like the opened stomach, but for solid organs the radiating rulings (shown in Fig. 51) give axes along which surface measures are

FIG. 55.—METHOD OF TAKING VOLUME OF ORGANS.

On the right half a cerebrum on a suitable enameled tray. A 1000 c.c. "Acme" graduate, previously filled to 500 c.c.; a cerebellum placed in it raises the fluid to 680 c.c., showing a volume of 180 c.c. In the center an Acme graduate holding 500 c.c. and two tall cylindricals of 100 and 250 c.c., for accurately measuring fluids, are used with jar on left. The museum jar on the left contains water to the exact level of a mark of a given number of cubic centimeters (2000) taken *with* the skimmer in. It was partly filled and one-half the cerebrum was placed in it; water was added until it reached the mark, from the empty graduates. The water not needed, owing to the size of the object, amounting to 490 c.c., is seen in the graduate in the middle. On the left is seen a skimmer for pushing down objects that float.

taken with a tape measure, and these can be easily plotted on similarly ruled paper, using the actually obtained measurements. To estimate surface directly or by plotting I know of no simpler method than by counting the number of contained squares. For this purpose we use quadrille ruled paper, square ruled glass, celluloid, and dissecting boards, all of which serve their purposes in different cases.

Volume, or cubic measure, is so closely related to weight because of the low specific gravity of the tissues, that one can generally read one for the other, but for work in any way comparable to the accuracy supposed to obtain in histologic work one should not be satisfied with such rough methods.

For volume measure, I use two sorts of graduates, the Acme shape,

W. T. Co., and the tall cylinder. These can be had in all sizes. I find 100, 250, 500 c.c. in tall cylinders, 250, 500, 1000 c.c. in Acme shape sufficient. For measuring the weight of the body I know of no simple convenient device. If I were planning a mortuary I would include one of two forms of butchers' scales, depending on the size of the room and the amount of money available. In a small room the suspended spring balance, with four chains ending in rings, to catch the stretcher handles. In a larger room a simple form of platform scales, with a large removable board top of fixed weight. Weighing tables are not satisfactory, and those built into the refrigerator are wholly unpractical.

Scales.—For weighing organs I prefer a spring balance with the mechanism above, so that there will be no opportunity to ruin the

Fig. 56.—Specific Gravity—Weighing in Air.

A simple form of balance mounted on a board is raised so as to allow jars to be passed freely under it. A hole is cut in this base board; through this hole a tinned skimmer is attached to the support of the scale pan and exactly balanced by weights in the opposite scale pan. The organ is then laid on the skimmer, which, being freely perforated, allows all fluid to drain off and fall into an enameled pan below. (Compare with Fig. 55, where volumes are taken by using the same skimmer and jars.)

scales with the slop and spill generally attending such weighing. The plea that a spring balance is not as accurate as those using weights is made by not a few persons whose ideas of accuracy do not affect their own practice. The spring balance, if properly made and tested, is quite good enough for ordinary work, and for accurate work only special scales and specially trained persons should be considered. The handling of accurate weights with hands wet with blood or body juices soon impairs the accuracy of the weights, and the reckless scouring of weights so common in the better-kept postmortem rooms is sure to introduce a very perceptible error.

In any case, a set of standard weights should be carefully kept for accurate work, and to test frequently the spring scales used for routine work. I prefer to have a set of weighed pans on which the organs can be placed after being properly prepared. This preparation is tedious work when rightly done, and there is little use in collecting masses of rough weights of organs as is too frequently done. Accurate weighing of organs requires special dissection, which will often interfere with the plan decided on as proper for the given case.

FIG. 57.—SPECIFIC GRAVITY—WEIGHING IN WATER.

Having balanced the skimmer and weighed the organ in air, the skimmer is raised and a jar containing enough water to cover the organ is passed underneath. The skimmer and organ are lowered into the water. Water from graduates may then be poured in so as to determine the volume. The organ is then weighed. Specific gravity = $\frac{\text{weight in air}}{\text{weight of water}}$ or $\frac{\text{weight in air}}{\text{c.c. of water as gm.}}$. The loss of weight in water should equal in grams the number of cubic centimeters of volume. We thus double check each with the other when we take volume and specific gravity. The correction for temperature and impurities in the water need only be regarded in the most accurate work.

Gloves.—When I began to use gloves some sixteen years ago I was subjected to great ridicule. I still continue to use them, and I hear less ridicule and, stranger still, I find the better workers have adopted them. I can conceive of no possible excuse for neglecting to use them. My reasons for adopting them were so simple and to the point that I will give them, because I find not a few persons still continuing the dirty old way:

(1) They protect the hands (*a*) from nauseous odors that are hard to remove; (*b*) from dangerous bacteria that are hard to destroy, and which can find an entrance after the operation is all over, it being spe-

cially difficult to cleanse the tissues about the nails, where so many postmortem infections started in the old days; (*c*) from the juices of the body which soak into the skin and greatly obtund sensibility; after two hours of soaking the hands are very much duller than at first, so that a true comparison of the condition of the tissues observed is greatly interfered with.

(2) They prevent the carrying of dangerous bacteria outside the postmortem room. Having infected myself in the dissecting room, and having seen others who had received similar infections at points of the body removed from the hands, I have been impressed with this danger.

(3) The objections to the use of gloves arose largely from the ignorance of the proper manner of using them.

Gloves should be of a good quality of rubber, not too stiff and not too thin. They need not be made of pure gum, but can be of a lower grade composition. The beginner may use thin surgical gloves for a while to accustom his hands to their feel and the way to handle organs and instruments, as well as to train his sense of touch. Gloves must not be tight enough to cause constriction of the hand or limit the motion of the fingers, nor should they be a bit larger than is necessary to insure freedom of action. Only a few days ago I saw an assistant attempting to make a postmortem with a large pair of gloves, and the effect was extremely saddening. Folds and wrinkles and projecting finger-tips must be avoided.

The *gloves should be put on dry*, otherwise the fingers will soak in the moisture and the sense of touch will be dulled, and one will not be sure when a puncture has occurred, and will, therefore, run an unnecessary risk.

In hot weather the hands will often perspire inside the gloves, and it may be necessary to use a little talcum powder if the hands are damp before putting on the gloves.

The *care of the gloves* is a matter of considerable importance. They should be thoroughly cleaned while on the hands with soap and water to remove all grease, and if they have hardened fluids on them a little Hand Sapolio is a great help. Then they should be dried carefully, and if the case has been one of a bad infection a few drops of strong formaldehyd solution should be rubbed over them, after which they should be dried, at least partly; a little film of the fluid may be left. Then grasp the sleeve at the top and quickly turn the glove inside out. If moist, they should be dried. They should be inspected for breaks or leaks both before and after using, and should be put away either in a clean towel slightly moistened with formaldehyd or put in a receptacle in which plenty of the vapor is being supplied. At no time should they be rolled up or folded so as to form creases. Grease of all sorts will rot the rubber quickly, and in hot weather a *little* talcum powder will prevent the adjacent surfaces from sticking together.

The glove should be long enough to come well above the wrist, and by rolling this sleeve one can test the soundness of the glove.

I never boil gloves, and have never had a serious infection since I

used them, though I have cut over 4000 cases, many of them being of a very infectious nature, and I can boast of no special immunity to infection. I have had gloves break in use, but by using the gloves dry I know at once, on removing them, and use liquid soap and pure formaldehyd on the exposed area. I have never seriously wounded myself, but have been wounded by assistants, once while taking out the brain of a hydrophobia case. In such cases I immediately changed gloves and used pure formaldehyd in the wound—a painful but safe proceeding. In chemical cases I always use new gloves and always have several pairs.

Wounds.—I have had occasion to treat a few cases of infection in attendants who either wounded themselves sewing up or by some other accident, and I have had uniformly good results by following the simple procedure which I will give in detail, because I have seen so much of the less successful methods in such cases which not infrequently end in great suffering and not rarely in death.

Treatment of Postmortem Wounds.—(1) Clean the wound at once with a bit of gauze wet with pure formaldehyd or strong (5 per cent.) carbolic acid.

(2) When dry, apply colorless iodin above and below the wound freely. This solution is not appreciated in medicine at present and is hard to obtain. I make it myself. Tincture of iodin, add 5 per cent. strong ammonia; let stand over night covered only with paper; boil off all free ammonia; make up loss by adding alcohol; remove all color by adding a saturated solution in water of hyposulphite of soda; let stand for several weeks before using. I cannot give the full chemistry of what takes place, but I know that the resulting mixture of iodin compounds is worth more in aborting boils and combatting infections than any if not all of the substances in the drug stores. It improves with age, has a peculiar garlicky odor, is very pale yellow, mixes with water, does not blister the skin, and seems to combine the good effects of iodin, iodoform, alcohol, and hyposulphite in its action on inflamed skin.

(3) If the inflammation has started, but is localized, I bind a pellet of blue ointment on the spot and paint the surroundings with iodin.

(4) If the parts have begun to swell I have them constantly soaked with a saturated solution of magnesium sulphate, and once or twice a day let the skin dry and apply the colorless iodin freely.

(5) If pus has collected in quantity greater than a few drops it will be absorbed slowly by these forms of treatment, but can be better treated by a combination of absorption and limited openings.

Accessories.—The handbag (Fig. 58) should be 16 inches long and 7 inches square. These are made as instrument bags by physicians' supply companies. The lining should be of oilcloth—not soft leather. Fig. 59 shows different sizes which are desirable for special work. The leather ones are best, but the expense is considerable, and the canvas telescope is almost as good and very cheap.

Glassware.—The Whitall Tatem Company make the best museum jars and reagent bottles, and also a particularly desirable wide-mouthed

bottle (Fig. 60, 9, 10). The "lightning" jars (Fig. 60, 2, 3) are made in half-pints and pints; both sizes are valuable, but the half-pint size is almost indispensable for small specimens, and is cheap. Labels should be written with a fairly hard pencil, or if with ink they should be coated with collodion or paraffin. Glass writing wax pencils do in the laboratory only.

Dissecting Sets.—The ordinary kits as gotten up by the dealers are so bad that one had far better go to a hardware store than to an

FIG. 58.—BAG AND KIT.

Reading from upper left: Bag, agateware tray, gauze, bottles for soap, alcohol, formalin, iodin, agateware cup, bandages, twine in envelope, gloves on towels, saw, probe, measure, 2 needles, side-edge chisel and small one, 2 small probes, aneurysm needle, small needle and repair silk, matches, long-handled scissors, 2 knives, sequestrum forceps, 2 hammers, hone, dissecting case, alcohol lamp, pocket electric light, lens, tapers, package of paraffined paper, note cards, 3 x 5 inches, pocket note-book, 2 specimen bottles, tape measure, dissecting forceps, chisel, retractor forceps, small probe with handle. The small instruments are placed in the tray, which fills the middle part of the bag, bottles at one end, supplies at other; paper, twine, etc., in pocket of bag, gloves rolled in towels on top.

instrument dealer, unless he is prepared to secure what he wants rather than what the dealer wishes to sell. The pocket dissecting set shown in Fig. 43 I procured in Germany in 1891, and have had in my operating bag constantly for sixteen years. It is still in fair condition, and is the most compact and satisfactory case I have ever seen. The instruments are all shown separately in the other figures. The whole is compact, light, strong, easily kept clean, and the tools are good.

Dental Instruments.—In the constant search for useful implements I have found many devised for special purposes in other arts which I

could use to advantage in my own. Thus it will appear in the figures that I have borrowed tools from carpenters, butchers, mechanics,

Fig. 59.—Chemical Kit.

Above is seen a common, cheap telescope bag of canvas, such as I formerly used exclusively for jars; below, a small kit bag for instruments (closed). In the left center a similar kit bag open, showing packing (compare Fig. 58). Right center, a leather hat box which holds half a dozen basins, towels, twine, sealing outfit, etc. Below, a large specially made leather bag holding jars enough for all the organs. Extra jars are carried in similar bags in special cases.

horticulturists, chemists, engravers, watchmakers, surgeons, dentists, ophthalmologists, sailmakers, draughtsmen, blacksmiths, fishers, and housefurnishers.

Many of the tools used by the dentist are valuable in special bone work. I do not recommend the dental engine because it is costly and hard to keep clean, but it is a good laboratory tool.

For *preserving specimens* I find that paraffin paper is very convenient, light, cheap, easily carried, and keeps well. It does not have to be cleaned, as it is burned after being used. Several sheets of this about the specimen protects it as well as the bag or other container. Newspapers, towels, cloths, or a paper box outside of this wrapping serve for carrying. Rubber sheeting is useful at times and is easily folded and is better than a bag; it will, however, age and spoil and give out at the most unfortunate moment. I have, therefore, dropped it for the paper.

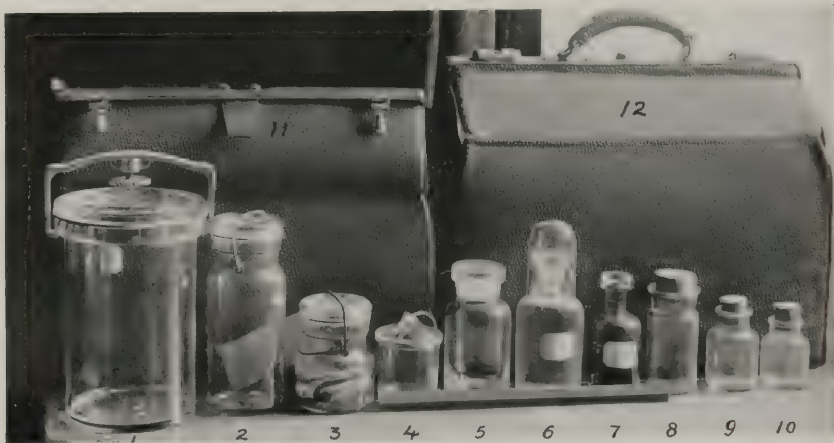

Fig. 60.—Jars, Bottles, Bags.

1. Museum jar, the best form of jar where chemical examination is to be made, though brittle. Can be had in various sizes. 2, 3. "Lightning" jars, cheap, simple, very useful; the half-pint size is almost indispensable. 4. A convenient jar, in the shape of a tumbler, without neck, useful in the laboratory. 5. The best form of glass-stoppered wide-mouthed bottle for reagents and useful for small specimens. 6. The best form of glass-stoppered reagent bottle, the glass cap prevents dust from getting on the lip. 7. Four-ounce bottle, same type, the most useful reagent size. 8. A convenient 4-ounce bottle with extra wide mouth. 9, 10. Two sizes of the best form of small specimen bottle; notice there are no angles. 11, 12. Carrying bags for museum jars. 30 cm. scale in front of Nos. 4 to 8.

Pocket Lamps.—In spite of the fact that daylight is the best light, we need other forms at times, and the little vest-pocket electric lamp is a great convenience. Matches and wax tapers have the advantage of not failing at the critical moment, as most battery lamps do. Before the arrival of the pocket lamp I carried candles.

Sharpeners.—Arkansas stone and oil gives the keenest finish to a well-ground edge. Carborundum and such compounds cut and give fair finish. For ordinary work I have settled back on the fine grit-stones so much used by the older German instrument makers or the easily procurable stones sold by Pike.

I have tried so many sorts that I almost said I have tried all sorts. Many a time I have used the slate top of the operating table, and for

cutting out a nick few stones are as good as a fine-grained hard brick. Having had so many instruments ruined by the stupid grinders, I have a dread of having them spoil my pet knives, and so I have two knives which have never been ground. The one shown in Fig. 19, 1, has cut over 2000 cases, and is good for 5000 more, provided it does not get into the shops. The reason is probably more that such grinding is good for

FIG. 61.—HOLDING SECTION RAZOR.

In making free-hand sections of small objects, the under surface of this razor is ground flat and slides over the forefinger of the left hand. The blade is pushed from toe to heel and at the same time forward through the object. The motion is obtained with a stiff wrist by moving the forearm. The reverse or "cutting from" razor (see Fig. 32, 5) is held in a similar way, but the blade is ground flat on the other side and the edge points away from the body. The motion is from heel to toe and forward, and is obtained by the forearm motion reversed; the flat side of the blade gliding on the tip of the thumb. These razors are used wet. The object here shown is a fine cork, which is the best material to practice on.

trade than that they could not do it properly if they wanted to. The razor-edge leads to whittling and hacking. The moderate edge is the only one for ordinary cutting. From my observation of surgical work and the results, I am convinced that we would see less of horrible accidents if surgeons would learn to use two grades of knives—one sharp in the extreme and a general one less dangerously keen.

PART III

EXAMINATION OF THE BODY

GENERAL

Extent.—The examination of the body of a dead person varies in different cases very greatly—from the simple inspection, as in a person burned in a conflagration, to the almost complete destruction of the body in exhaustive chemical investigations.

In some cases only a few things, in other cases many things, must be done; as examples—A simple viewing of the body of one dead from malignant small-pox would be in most cases all that should be called for. In diphtheria the throat should be examined, and if any doubt remains, a culture taken. Great violence will often make it impossible to conduct a routine examination of the organs. There are a great number of cases where partial examinations are entirely proper. One must never forget the possibility of being misled, on finding some striking condition, into ignoring some less striking but very important condition. Nor should one be wholly guided by the history, for even medical men can give the most weirdly incorrect accounts. I am constantly called on to investigate cases where what appears to be a perfectly clear history is found to be utterly incorrect. These illustrations will show the types one often meets:

W. was taken suddenly sick and died in less than half an hour; four doctors were in attendance; all ridiculed the possibility of poison, but each differed slightly as to whether the heart or the kidneys or an apoplexy was the cause of the death. The man was found to have taken some ale which contained all the cyanid of potash it would dissolve.

B. was taken to a hospital, when poison was diagnosed, and a great mystery was built up. On sending for a couple of negro women, I became satisfied that it was a case of cerebellar apoplexy, and invited several gentlemen to see it opened. I must confess I was derided until I opened the skull and took out the cerebellum.

D. was in a fight; treated at and discharged from a hospital; seen by several physicians, each of whom insisted that the man died of alcoholism. The family asked for an examination. I found fracture of skull, contusion, hemorrhage of brain, and beginning meningitis.

Miss N. was hurt in a trolley car, and I was to determine the extent of the injuries. She had no injuries, but a very bad abscess in the throat, with extensive secondary ulcers in the bowels.

L. died in a hospital of heroin poisoning, and great was the indignation when I pointed to the facial contracture and then cut out an apoplexy.

Mrs. W. fainted when her husband's automobile collided with a wagon. Two physicians were quite sure no examination was necessary, and that she had died of heart disease. I found the chest had been crushed by one of the shafts and the heart severed from the great vessels.

F. had a fall and a slight swelling of the knee followed. The hospital gave alcoholism and nephritis. I found a pint of pus in the knee.

R. had been working in the garden. The family claimed insurance on the grounds of sunstroke. I found one coronary wholly occluded and dilated beyond the obstruction, and terminal myocarditis.

Johnnie S. had been punished by his teacher a few days before death. It was claimed the teacher killed him. I found a large glioma.

B. was suffering with "dementia præcox," though rather well on in years. I found ozena, and on dissecting out the sphenoid cells found them full of pus, the infection extending to the pituitary.

I have given a few of the types which one may meet in the day's work in order that there may be no excuse for making improper examinations, because I point out that exhaustive investigations are not always necessary. Such misleading histories are the exceptions, and we must largely base our plan on our history.

The **senses** should all be busy at an examination. It is not sufficient to use the eye alone, though an alert and trained eye is of the greatest value. I used to offer to make a postmortem in the dark with better results than those attained at the average autopsy. Nor was this an idle jest. Much less was it crude boasting. Rather was it a pointed plea for a better training and a more rational and thorough use of the other senses.

The *eye* should be protected from bad light. I am in the habit of wearing a soft hat, the brim of which furnishes an excellent eye-shade. The principles of reflection and refraction, diffusion and absorption of light if properly grasped will tell more about the condition of tissues than could be guessed at by sections viewed under a microscope.

One can profitably study expert buyers of goods to gain an insight into the significance of physical properties and their detection. How quiet yet purposeful are the movements of the hands of the expert who is examining wools or cottons, or tobacco, or cloth, or yarn. Only the greenhorn buys with his eyes alone. The saddest part of it all is to compare the work of a real expert in any work with the ordinary maker of postmortems.

To understand tissue requires skilled use of light. It should become second nature to judge of the translucency or transparency of the surface looked at, and one must realize where the light is reflected in the tissues.

This does appear like a refinement, but do we not recognize by habit the difference between satin and cotton cloth or between parchment and

plaster of Paris? So we must recognize the quality of the fibrous fabric in the tissues, and no comprehension of the tissues will ever be reached if we ignore the optical properties of the elements, not simply in greatly changed conditions in the sections under the microscope, but in their fresh unaltered condition at the postmortem and under the surgeon's knife. For the estimation of relative values we use standard light, but for gaining insight into the nature and optical structure of tissues we must experiment with every sort of light of every quality and degree of

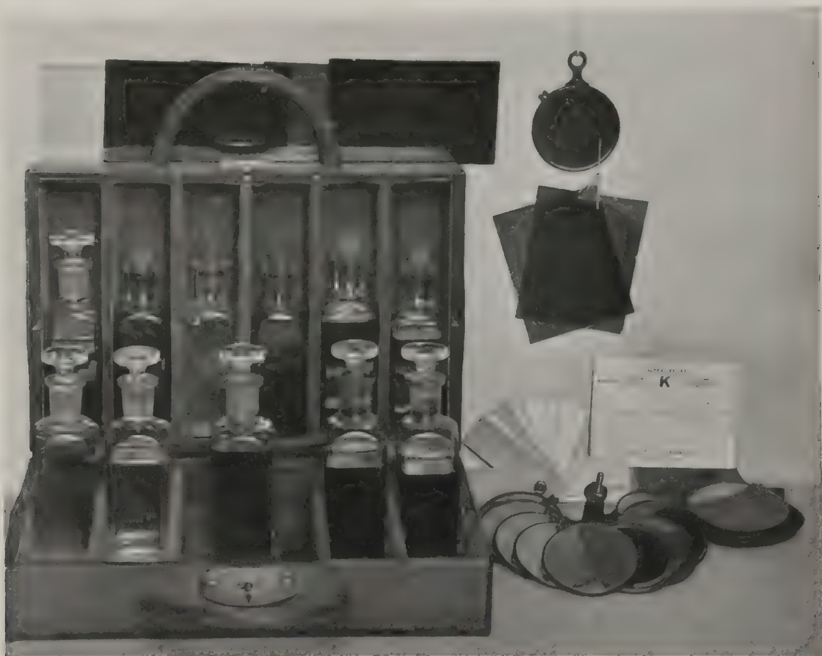

FIG. 62.—An oil sample case fitted with 4-ounce bottles containing solutions of standard colors. Reading from the left: Blue (sulphate of copper); green (nitrate of nickel); yellow (picric acid); orange (bichromate of potash); red (Lugol's solution of iodin, diluted). The actinic property of these colors shows very clearly. Above are seen a series of tested colored glass plates. On the right above are photographic color screens; below, the Bradley paper series, the nearest approach we have to a graded color standard. At the bottom a set of frames holding colored gelatin between two pieces of glass. These have been tested with a spectroscope. With the bottles any color can be quickly and accurately analyzed by looking through the bottle at the object.

intensity, and from every direction. Where through-and-through illumination can be practised it should not be neglected.

Color analysis is another refinement that is foolishly ignored by the majority of operators.

The **color** of an organ or tissue can be studied by a trained eye directly, but better results can be attained if some standardized color screens are used, such as the screens used by photographers or, better still, by test solutions of positive spectra. I used picric acid for yellow, nickel nitrate for green, iodin in potassium iodid for red, and ammoniated sulphate of copper for blue. They are permanent. These being selected

after many hundreds of tests. They can be put in flat or square bottles. I use 4-ounce square. Each color absorbs its complimentary color, so that the organ containing that color is darker in proportion to the amount. Thus, a red organ is black through a green screen. It must be remembered that ordinary colors are so impure that no reliance can be placed on the results obtained by their use, and the general crudeness of color knowledge is in marked contrast with the clamor so often raised about the medical sciences.

In Fig. 62 is shown a frame with two plates of glass, 10 cm. in diameter, with ruled lines. I have a series of such glasses with colored gelatin that I had made for color analyses when I was a student, but they are inferior to a set of solutions for standards, though easier to use. I proposed that we have an international set of color standards in Munich in 1896 at the International Congress for Psychology, but the scientific world moves very slowly in matters that are quite obvious, and colors are still described in the most haphazard way.

The **spectroscope** is used to a limited degree in the laboratories, but for the study of colors of tissues it is not practical, and some standard screen that can be easily held between the eye and the object is the simple way. The plan of matching colors with scales that are printed or stained is defective because they do not assist the eye, but rather rely on an organ very apt to be defective, and the standards are seldom accurate when made, and fade so badly that they are soon worthless.

Colors should, so far as possible, be estimated in terms of the four primary colors—yellow, blue, green, red—orange and violet being so hard to analyze and so rarely needed that they may be ignored in the study of tissues. Shades and tints give browns and grays, and indicate interference or absorption of color so generally that, aside from the mass of light, they are but little considered. All descriptions should indicate whether the color is saturated or strong, or whether it is dark or light, by reason of absorption of or reflection of light. The use of the terms "shade" for colors with little light, and "tint" for colors with much light mixed, and "deep" and "pale" to indicate strength of color, is desirable.

Touch.—The compound sense which is made up of all the sensitiveness resident in the fingers, including sensations of pressure, temperature, muscle sense, space perception, and surface inequality or contact sense, gives a varied set of data that is too often ignored in postmortem work. The size and shape, the mass, consistency, and texture of a tissue can be judged by the hand and eye working together, but the elasticity, rigidity, and resiliency can only be judged by the sense of touch. The tensile strength of tissues, a matter absolutely vital to surgeons, one hears little of, but time, the great healer, may improve even this neglect. Certainly, no one who is studying the human body at a postmortem in any case, even remotely surgical, can afford to neglect this *terra incognata*.

How tissues retain their positions and shapes and resist compression, give support for operation, and the diseases of tension should form a large part of our work. To this end, well directed tests by press-

ing, pulling, squeezing, breaking, tearing, and stripping parts of organs and tissues must be carried on as a matter of habit for some time before the expert insight into the dynamics of tissues can be attained.

Smell.—While this sense is generally offended by the odors, there is far too little attention paid to the meaning of the various smells which belong to the body. We easily recognize the importance of the detection of such odors as that of opium, the cyanids, carbolic acid, alcohol, and other drugs, but the odors of the organs in health and disease should receive a vastly larger share of attention than has been heretofore given. True, these odors are from chemical substances which have been but little studied and frequently unrecognized by the organic chemists, but their association with disorders and disease is so striking that they should arouse us to a keener perception of their occurrence and a closer observation of their significance. We know the smells of favus and of pus of many types, and recognize a large group of fever smells and uremic odors of a whole series. Gastric contents, the liver, the blood, and the brain have odors that vary greatly and most significantly. The odor of the urine is of no slight value to a trained urinologist. Unfortunately, one has to be very general in treating of this subject, because we have but very little data as yet to formulate our deductions on, but practically the use of the sense of smell is of value even with our present ignorance.

Hearing.—Percussion of the body, of tissues, and of organs gives not a little information. This is just as true of the dead body as it is of the living, and for the study of the bones it is of vastly more importance in the dead. Fractures of the skull will never be understood unless the bone is percussed, and the note given out when bone is properly struck tells something of the nature of the bone that cannot be gained in any other way.

To understand how the fracture occurred as it did, both in position and extent, one must have a good conception of the condition of the bone. The location of the organs can be determined before cutting, and the thoracic viscera made out as to position and condition.

In all cases where any question of the position of the organs is of significance, either actually or by reason of theories of medical experts, such percussion is to be carried out.

I am not infrequently helped by the information gained by using the back of the knife as a plexor. The collapse or distention of organs, the presence of tumors or fluids, and the outlines of the organs thus roughly outlined and fixed not rarely helps to determine on some departure from the routine cut which is of distinct advantage. Specially is this true where fluids are present in large amounts in private-house cases; a bad spill is thereby avoided.

Helps to the Senses in Observing.—We have already given, under Instruments, those things that are useful for determining size, shape, volume, and weight; and under Color we have mentioned standards that have been fixed with relation to the spectrum. There remain a few important aids to investigation.

X-ray Apparatus.—The installation of a high-grade plant in the postmortem room would entail an expense that would be justified only by the assurance that high-grade work was to be done, but most hospitals have old tubes and apparatus that are not up to modern requirements for clinical work, but which could be transferred to the postmortem room and would serve an excellent purpose. We know almost nothing about the relation of the obstructing of the various tensions of radiant energy by normal and pathologic tissues because there has been so little systematic work. We sorely need a well-developed *x*-ray anatomy first, and next an *x*-ray pathology. The accurate measurement of an organ, with its specific gravity noted and determination of its radio-absorption, as determined photographically with a standard radiochromometer, penetrometer, or other *x*-ray scale, would give us something definite to go by and work from in our study of the density and concentration, both chemical and biologic, and of the changes in health and disease that would take pathology a long step in the direction of the exact sciences.

When I began to study organs by means of the *x*-ray seventeen years ago this was impressed on me, but the work had not progressed far enough then to make my suggestions made before the Philadelphia Pathological Society seem practical, but after the progress made since that time I venture to again point out the value of such work.

Certain cases come to the postmortem that have been examined in the *x*-ray laboratory, and one must be able to interpret *x*-ray shadow pictures or be annoyed, if not seriously handicapped, by his failures.

Not all workers in *x*-rays can be implicitly relied on, and I have had on several occasions to send for the plates after having been misled by statements, only to find grievous errors of interpretation of what the plate actually showed. The use of some form of standard scale should be insisted on. I personally prefer a wedge of aluminum, with lines made by inlaying fuse wire of lead at regular intervals, though other forms have special advantages.

In considering any picture or shadow, either on plate or fluoroscope, we must remember that we are dealing with a projected force.

Rules for Study by x-Ray.—(1) That this force passes in practically straight lines from its source.

(2) That the effect varies as the square of the distance from the source.

(3) That the source is a surface, not a point, and, therefore, that there is not a sharp outline of the object unless the object is close to the screen. This can be plotted by drawing to exact scale the source, the object, and at the known distance the screen, with the shadow actually found.

(4) The shadow will have a dark center if not too far from the screen, but if the object is smaller than the source and far from the screen there will be only the penumbra, such as is seen in a partial eclipse of the sun.

(5) Tissues surely have the power of altering the direction of the

rays. Whether this is due to diffraction, as in light, or whether they act as in heat by becoming secondary sources of emanation, has not, I believe, been settled.

(6) At all times the object should be as near the screen as possible.

(7) Where possible the stereoscopic method should be employed.

(8) Carefully located landmarks should be marked by metal pieces.

(9) The data that should always be included are—

(*a*) The distance of the source.

(*b*) The direction of the ray.

(*c*) The posture of the body.

(*d*) The position and angle of application of the plate or screen to the body, and the angle it takes with the axis of the ray.

(*e*) The power of the tube—perhaps best indicated by some standard scale.

(10) The perspective, which is greatly exaggerated, often distorts the picture. This is taken advantage of by the expert, specially about the face, but for postmortem work or work on tissues I prefer to use the tube at considerable distances, so that the rays are more nearly parallel.

(11) Occasionally a plate is exposed reversed—glass surface toward the source. I have had such a plate of a bullet shown to me without comment, and, not thinking of such an error, much time was wasted. If such an error occurs a note should be written in ink on the margin of the plate.

(12) Developer spots have been shown to me as stones, bullets, or tumors, and it is not always easy to detect this class of error.

(13) In studying a plate always so orient the plate that you are sure it is in the right direction as to top and bottom, front or back, right and left, or that the surface is in the right direction. Too often this is neglected.

The value of the *x*-ray in determining the position of the organs will depend on the wisdom of the operator. A great majority of anatomies picture the hyoid bone in a position that is nearly horizontal when the body is erect. This is an error, as it is nearly always placed at an angle, generally nearly parallel with the lower edge of the jaw.

The *x*-ray pictures curiously have the horizontal position, which can be easily understood when we see that in order to obtain the picture the head is bent sharply back, and the chin being raised the hyoid is no longer in its usual position. Certain workers use a tube above the body and get the organs only in their position when the body is nearly horizontal. These will not correspond with pictures taken of the same body if erect. It must always be known in what posture or position the body was when the picture was taken. This matter of position is equally important in the study of the dead body and of organs.

Measurements of organs should be taken when they are in exactly the position in which they are skiagraphed. This is so simple a source of error that it might seem unnecessary to mention it, but it is one I have seen made, and the person making it failed to appreciate the mistake when his attention was called to it.

Records.—The simplest form of record is the memory, and the courts in this country pay little attention to written records unless taken at the time of the examination, though they pay a great deal of attention to the records of memory. The philosophy is characteristically legal in its folly, because what one remembers to say in court under the distractions of a hearing should be less accurate than a record written just before under good conditions.

For court work the memory must be trained to hold fast and firm not only the essentials, but many details that are really not important. One finds the training of the memory a very necessary part of medico-legal work, and one takes such notes as will help the memory. For scientific work one does not tax the memory in this way, and instead finds a paper memory. The danger of such a habit as is formed by the immediate dictation of notes is that the records will degenerate into a senseless lot of details with little real thought, and consequently of vastly less scientific value. I am convinced that for the best grade of work an intermediate plan is best where the memory is trained and taxed whenever any matter of thought is concerned, and only such matters as weights and measures are to be immediately dictated when taken.

A few practical hints regarding the working of the **memory** may savor of psychology, but if they are practical and useful they will be pardoned though coming from such an unpopular science.

Mental pictures must be clear, limited, and of a certain intensity; must last for a certain time, and be perceived with a certain alertness in order to be retained in the memory.

Mental photographs are not so very unlike other kinds of photographs which require careful attention, true focusing, and the proper impressive force, as well as avoidance of motion.

Overexposure gives weak pictures in the mind and on plates. Underexposure gives only the high lights. One must, therefore, always be on the alert to properly expose the sensitive brain cells.

No two persons have the same memory strength, and all find themselves more competent in remembering some particular sort of fact. Let the person find what they can best learn, and observe how they memorize that particular sort of mental picture, and apply the same method to the formation of the desired pictures, using the same sort of concentration and allowing the same length of time.

Memory being the basis for scientific thought, there is no way to make progress without such discipline. The memory will not always work quickly and strongly and we must help it with notes.

Note taking is so simple that every beginner has a system all his own long before he knows what he is about, and the marvelous systems of taking elaborate postmortem protocols have largely emanated from very young persons. All larger hospitals have been experimented on by these young enthusiasts, and the systems have been replaced time after time as each new arrival comes upon the scene.

The young man makes a careful list of all the organs and of all the diseases he is familiar with, puts them down in a scheme, spaces the

wonder with utter disregard to utility, and has the only complete post-mortem book.

The best record book has no such scheme, but is a simple blank book, or at most with a simple heading in which is a brief set of data, such as name, age, sex, date, ward, diagnosis, etc. If there is any question regarding the overlooking of an organ there can be prepared a guide card which can be held in the hand or printed large and hung on the wall, but to have the page cut up in spaces for each organ when in one case organ *a* will be normal and need no comment, but in the next case it may require much space, is clearly absurd.

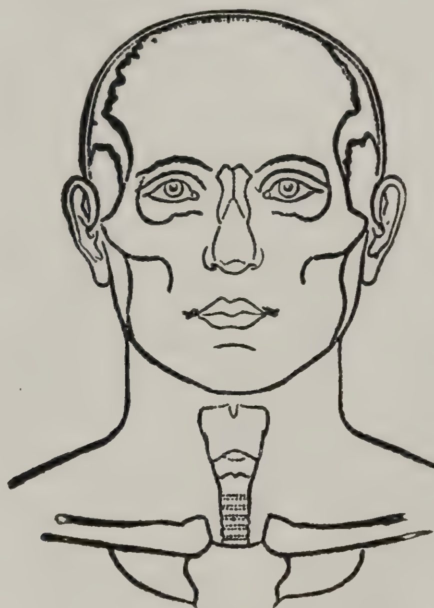

FIG. 63.—FRONT OF HEAD AND NECK.

These outline cuts, which are made from the easily obtained rubber stamps, while far from being accurate, are very useful. I always carry an assortment of stamped slips about 3½ by 4 inches. This allows margin for explanatory notes, corrections, case, name, date, and measurements, including angular estimates. When filled they can readily be attached to the permanent notes, whether on sheets, cards, or in books. (Compare Figs. 64–66.)

Notes.—In taking notes the name of the organ is written in the left-hand margin of the page or card in such a manner that the eye easily finds it. The name of the case at the top and the serial number preferably in the upper left or on top in the middle. Age, sex, social condition, residence, date of examination, date of death, and important historic data follow. The rest of the protocol will vary with the use to which it is to be put.

In private notes I prefer cards which can be easily filed either by number or name or date and cross-indexed.

In my public work I have always used a small note-book about 4 x 7 inches, bound in leather board, containing 120 pages. This can be con-

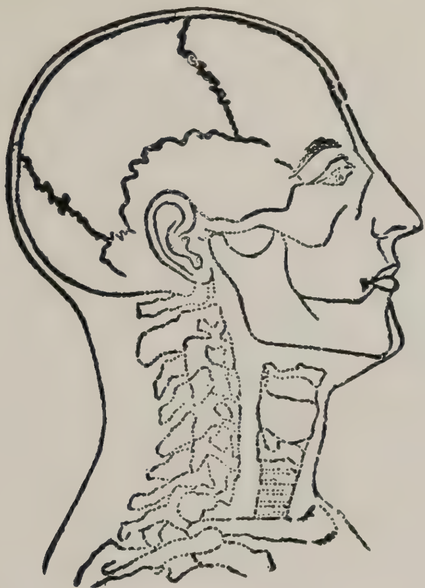

FIG. 64.—SIDE VIEW OF HEAD AND NECK.

This may be reversed for the left side. While very crude, it saves much time in ordinary cases, and in special cases is supplemented by photographs and carefully made drawings.

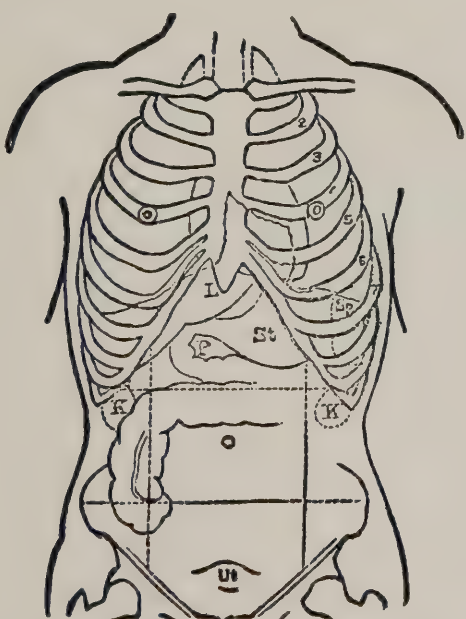

FIG. 65.—FRONT OF BODY.

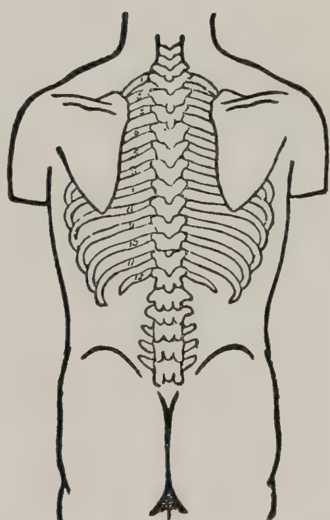

FIG. 66.—BACK OF BODY.

Chiefly useful because they lay down the landmarks, and specially valuable in plotting wounds.

veniently carried in the pocket, and these books can be filed like cards in an ordinary desk drawer, being stored in tin cash boxes as the cases are closed. Only once has a judge ordered me to give up my notes to a crooked lawyer and allowed him to make improper use of the book. This judge, not being familiar with the ordinary amenities of life and the decorum of the courtroom, and being entirely exceptional, I have no hesitation in using a note-book containing several cases, but if one had to appear before such a judge often one would use separate cards for each case.

Diagrams such as shown in Figs. 63–66 are very convenient, and can be stamped on thin slips of paper and carried in a pocket-book, and after filling out can be pasted by the lower margin on the page of the note-book.

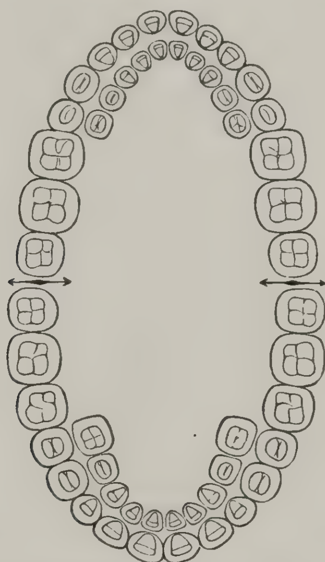

Fig. 67.—A Convenient Blank for Recording All Sorts of Findings About the Teeth, Whether for Identification or Descriptive Purposes.

I formerly made rough sketches, but the diagrams save time and energy, and are so nearly accurate that slight corrections can be made when necessary.

Indices.—The material will accumulate after a time in such a way as to be inaccessible unless some form of indexing is kept up.

Formerly, I had large list cards of special sorts of cases, but recently I have adopted the forms of printed cards shown in chapter on Coroners. The Hollerith system of perforating cards is the most complete and satisfactory method of keeping accessible indices for cross-reference, but the method is only applicable where a large amount of work is being done and requires a trained clerk.

Extra data, such as letters, fully written out statements, histories, photographs, laboratory reports, should be filed with the case number

and the name and date on the outside in some form of envelope or folder. Modern business has largely adopted the loose-leaf form of keeping records. I advocate a system for keeping postmortem and laboratory records on such blanks and filing in folders of Manila paper which fit the drawers of a filing case. This has been in use in one of our large hospitals for a number of years, and I believe that it has been proved to be practical and satisfactory, but this hospital is well managed, and the notes are preserved. In less well-managed institutions, where the records are likely to be mislaid or lost, one must be contented with what I regard as an inferior method, that is, the blank book.

No system will prevent abuses, and whatever system is chosen will not please every one. The choice should be made with regard to the moral and intellectual development of those who will have access to and use of the records. It is a mistake to have too perfect a system for either too busy, too careless, or too stupid persons.

Pathologists who have control of their department may adopt the system best suited to their advancement in the arts of orderliness.

I believe the loose-leaf system is the best, and the decimal system punched card index with a hole for every specially noted organ will render the whole mass of data quickly available, specially if a sorting machine is included as part of the equipment, as is done by the Pennsylvania State Department of Health.

The **notes themselves** must vary with the case, the point of view of the person making the postmortem, and the object that it is made for. Nor is this undesirable. The greater the thought given to the work, the greater will be this variation. The less the thought, the more perfectly will the routine be followed out. Everything of importance should be noted, but something may not appear important at the time which subsequent study shows to be absolutely vital.

It is simply impossible to note everything that could be observed at a postmortem. This can be easily seen if we take a class of bright young observers and assign one topic to each, say, the connective tissue to one, the blood-vessels to another, the nerves to a third, and each organ to another. After an hour collect the papers and dictate a good set of notes on the case; then compare these notes with the reports of the dozen or twenty observers.

It is evidently necessary to select in each case what appears worth noting, and the opinion at the time should have weight. Therefore there should be some indication as to the relative importance of such things as are noted. The long-drawn-out and absolutely unintelligent string of data without attached values is the worst form of record one can make. I do not believe that I should omit a word of criticism of the dreary records that one has to go over.

I know of no better example of this stultifying misrecording than is found in Virchow's second example. It contains seventy-nine paragraphs. The examination consumed, we are told, two and three-quarter hours, and the most important feature of the case, the gunshot wound,

is so badly handled that after studying the protocol carefully I am still unable to get even a shadow of a picture of the wound as a whole.

The wound is taken up in parts in a number of places, but the lust for chatting about organs has entirely obsessed the writer until he has forgotten the lesion.

This is the great error of modern work as I find it. If we can get through with the preliminary study of organs and get down to the real business—the study of conditions, lesions, and diseases—we will be in a more hopeful position.

I may describe a gland in the mesentery and an ulcer in the bowel, but if I do not note that the gland corresponds with the ulcer and its involvement is associated with the ulcer, I have utterly failed in my work. If I find a bruise on the head and a hemorrhage in the brain and do not establish the relationship between the two, of what use is my testimony in court? Yet I am constantly brought into contact with just such work.

Nothing has done more to retard pathology and bring discredit on postmortems than this scattering of the organs and parts until a reconstructed picture is wholly impossible. The test of a protocol should be that it gives a picture of the case, not simply of the shreds and tatters into which it has been torn.

If a lesion or other evidence of disease is found it is very apt to involve more than one organ. It almost surely will involve adjacent tissues, and it must be considered as a unit, but how can we do this if we adopt some routine that is nothing but a sophomoric list of organs?

How can a matted pelvis, with abscesses, adhesions, swollen retroperitoneal glands, contractures, occlusions, and displacements, be described adequately on the organ basis? The thing is palpably absurd. Nor is it less absurd to try to express diffuse general diseases in this way, and when we come to the subject of wounds and injuries and their sequelæ the folly of it becomes depressing. This brings us to a discussion of

Routine Methods for Examination of the Body.—We have Virchow's word for it that before the passage of the law the condition of affairs was simply horrible. While the reform brought about by these laws in the various states of the German Empire following the Prussian law of 1875 have probably ameliorated the conditions, it is quite evident that many more Virchows are required to revise and rearrange these laws and extend the cultivation of the art of making postmortems before the results will be modern or admirable.

It is clear that laws and regulations and rules will never build up any art.

Only recently I had to read a lot of testimony where the so-called expert followed fairly closely the German rules, and the result was one of the most abominable things I have ever met in the way of medicolegal pretense and error.

Cast-iron rules do not build men or art. We recommend the read-

ing of the German rules for making a postmortem because they contain much valuable thought, and from a historic point are most interesting, but as by actual count nearly one-third is to be eliminated as faulty or actually bad, we caution the studious and enthusiastic young man that he will hardly be in a position to read this remarkable classic with profit until he has been at the work some years, because his fancy may dictate that he accept the errors and reject the good if he attempts to use it critically, and to accept it all will stultify him as it has not a few others in the past.

From the point of view of a medicolegal expert it is still worse and should be practically ignored. The following slavishly of a set of perfect rules would not make a good operator.

The technic of hand and eye and mind must grow together, and the knowledge of anatomy, physiology, pathology, and chemical biology must be built up, and easy paths of approach to this knowledge must be established so that he can think easily on any new problem. There are some interesting lists of what to observe, and the book published by the English Medical Society of Observation in 1852 (also subsequent editions and reports) is of vastly more value to the man wishing to perfect himself in his art than the following of set rules. Let him examine one case observing what is listed in that book, and he will be vastly better equipped than if he enslave himself under rules, unless he be of the sort fit only for such base methods.

When called on to make a postmortem on a body one should form the plan that is best suited to the conditions of the case, and this will have to be modified as the conditions found demand. As a result an expert examines each case in a slightly different way from every other case.

While this seems to preclude the adoption of any routine method, there are certain general principles which guide us in the majority of cases, and we form habits of approaching our task that are full of method that at times conform to the rigid routine so often advocated. This routine helps the beginner and the teacher who must use some of his attention in impressing beginners, and we will give an outline which may be followed under such conditions, but always insisting on the principle that we must be always individualizing in making postmortem diagnoses just as in those on the living.

The routine examination consists roughly, then, of—

(1) Inspection of the exterior and surroundings.

(2) Careful examination of details that can be done without cutting.

(3) Preparation of plan for dissection, based on history and results of exterior examination.

(4) Dissection of the body according to that plan:

(*a*) Opening thorax, abdomen, and skull, and inspecting contents organ by organ and part by part, as well as relations and conditions.

(*b*) Freeing organs with as little cutting as possible.

(*c*) Dissection of individual organs and parts.

(5) Preparation of material that is to be preserved for special examination.
(6) Such anthropometric observations as may be desirable, including weights, dimensions, etc.
(7) Tracing all lesions and following up all clues of spread of disease, and determining extent as well as location of disease processes.
(8) Drawing proper conclusions as to values of findings as to age, relationship, and significance.
(9) Taking such notes—mental, written, or photographic—as opportunity demands and permits.
(10) Repair of body.

The details of the external and internal examinations will be taken up first in general sections and then by organs, followed by a section on interpretation of findings.

EXTERIOR

Identity.—While this matter is of recognized importance in legal medicine it has not received sufficient attention in the routine work. I say this because I have had the wrong body brought to me by mortuary attendants, and I have seen most distressing mistakes made by others. Several times I have known of the wrong body having been dissected by pathologists at hospitals. A case came to my attention recently when one body was cut for another, no permission having been obtained for examining the body that was cut. Serious complications arose.

The least that can be done is to be sure that the body is the one that is to be examined, and for which a permit has been obtained.

The question of who the person really was must necessarily be settled before permission is obtained from those who have a right to give such permission. Only in cases of the unknown paupers or when the body is unclaimed, and the anatomic boards have no prior rights, can such identity proof be omitted. In private-house work there is usually little trouble about the identity of the body. In hospitals it is of vital importance that the records of diagnosis and treatment and those of the postmortem should correspond, so that confusion may not arise.

In hospitals every body should be tagged as soon as pronounced dead, and this should be superintended by the resident physician at the time. The name, time of death and date, with the ward and the doctor's name should be on the tag. A hard pencil is better than ink for such tags. These tags should under no circumstances be removed except under competent supervision.

In **public morgues** all bodies should receive a numbered tag with the name, if known, and with sufficient space for subsequent corrections when duly identified.

There should be a record of the time and date of receipt and how received, and where the body came from, and if more than one person is in attendance the person receiving the body should be noted. If blanks are filled out and kept in the mortuary office they may be serially

numbered, and a thin copper coin or tag containing the same serial number, with such other marks as will show clearly the year and the morgue in which the body was received. Such tags should be attached to the great toe by small sized copper wire so that they will not come off, and should only be removed by responsible persons. If the body is buried in the public ground or sent to an anatomic board the tag should remain. Anatomic boards may add their own tags, preferably of block-tin, when bodies are put into vats.

The **name** of the dead person may be unknown or it may be an assumed one or an alias, or there may be a false identification. Such cases are far from rare in the public service, and are not always confined to medicolegal cases, though they are more common in that class.

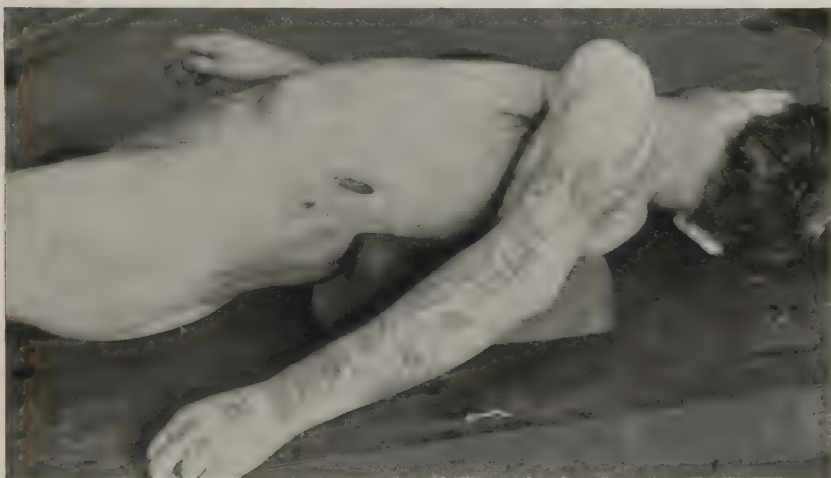

Fig. 68.—An Excellent Example of Tattooing Such as is Often Found on Criminals.

Wounds of the side inflicted by a heavy pair of shears which had been thrown from a distance, one blade penetrating the spleen, causing death by hemorrhage and sepsis. *Lividity* is slight and is seen as a fine mottling, most marked on the front of the belly. No one knowing this man would be apt to fail to identify him by the marks.

One must remember the dangers attending carelessness in these matters, and the complications likely to arise as soon as any matter relating to property arises, either actual or claimed, such as insurance or damages or inheritance. It is not uncommon for persons to change part or all of their name in ways not recognized by law.

Children born of single women are often called after the person who is said to be the father. Women have remarkable fancies about assuming a name of one or another husband or of some one not legally their husband, or of resuming their maiden name while married.

Foreigners not infrequently assume a translation or an Americanized form of their right one or a wholly new one, and when search is made by their relatives or by the consuls of their native countries no end of trouble results. Criminals frequently change their names, and if any

suspicion arises that such persons are under observation the police should be notified.

Establishing Identity.—When the body is in good condition a simple view of the face generally suffices, but many cases arise where the hands, hair, clothing, teeth, and bodily peculiarities must be studied before identity is established.

Measurements are, as a rule, unsatisfactory. Finger-prints are conclusive if one has access to a record of such taken during life, but these are seldom taken except in cases of criminals. Tattoo-marks, moles, birthmarks, and deformities have all served useful purposes when known to exist. Where doubt exists, photographs should be taken before postmortem changes alter the character of the countenance.

In mutilated bodies the problem is at times difficult. One body I had identified by a bit of cloth of a waist which had been saved from the burning by the leaking of the juices to the back. Another by a bit of lace similarly saved at the back of the neck.

In another case where two women were burned beyond recognition in a conflagaration it was possible to tell which was the older one by the condition of the uterus of one, though heads, arms, and legs were burned away. In such conflagrations as that of the Charité Bazar in Paris many bodies may be identified by the dentists, who had records of the teeth of those burned.

If one makes a complete list of the peculiarities of the exterior of several bodies he will be surprised to find what appeared to be very similar bodies are different in many details, but as persons who make identifications of bodies are generally very careless observers such fine observations are more apt to confuse than to aid them. Descriptions of the unknown must be practical. A very considerable number of persons are never identified, and not a few are buried under wrong names.

Postmortem operators have at times a serious duty in helping to discover the identity of a body. At such times they must be on the alert for all anatomic peculiarities. All marks or scars, all evidences of the effect of occupation or habit, and all signs of diseases that could have given signs or symptoms during life, as well as nutritional peculiarities of the parts of the body. In such cases it will be important to study the clothing.

The **clothing** which is found on a body often gives one clues that could be found in no other way, which are of the utmost importance in understanding the postmortem findings.

Thus, a brass worker, or a painter, or a workman in chrome salts or any other dangerous work has marks or stains on the clothing that may lead to the detection of some disorder resulting from his occupation that might be obscure unless a very clear history were obtained, and then one might not be able to judge of the contributory carelessness from the history, but could get an insight from a glance at the clothing. The odors about clothing may tell the whole story. Foreign matter,

such as dusts, oils, or vomit, blood, or other discharges, stains, peculiarities of shape, or of areas showing wear.

The **surroundings** in which a body are found often help greatly in solving the problems. Evidence of lightning, heat, cold, gas-poisoning, electricity, suffocation by fumes or gases, struggles, fits, falls, woundings, poisons, weapons, letters, sickness, medicine, vomit, etc. One must not be misled by appearances into jumping at conclusions, for many findings are explained easily by some theory that is not in keeping with the facts. A bottle of medicine might suggest either the disease for which it would be suitable or an overdose, or that some mistake had been made in compounding it, whereas it did not enter into the case in any way.

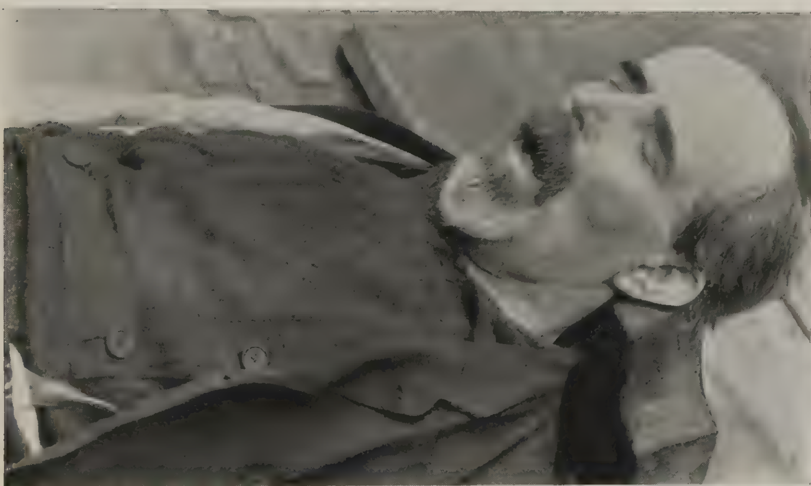

FIG. 69.—This photograph shows a number of things: There is an indescribable something which surely tells us the man is dead, without any tests. This something we instinctively recognize, and though one hesitates to call it a sign of death, it is one. The hair is characteristic of chronic gastritis. There is a bullet hole in the lower part of the shirt front surrounded by a smudge. The man had pointed his revolver at the spot where his distress had been located. This smudge was confined to the clothing and showed that the revolver had been held close to the body.

A very common error is to suppose that a liquor bottle found in the room means alcoholism, or that what is found is associated in any direct way with the body to be studied. This subject is oftenest of serious import in medicolegal cases, but I am so constantly called on to correct errors in this field of observation where no medicolegal element should have been injected into the case that I know the need of caution.

Foreign substances in or about the body or in the orifices or on the clothing form no small factor in medicolegal cases as well as ordinary ones. There is practically no limit to the list of such substances that have been found, and the range of cause and effect is very wide in each. It is, however, well to remember that these may have reached their position after death, in which case their significance may or may not be

important. Any foreign substance found in or about a body and also in the openings must be investigated, and where it is also found inside the body its importance greatly increases.

The habit of plugging the openings of the body after death will produce changes in those special parts that might seriously mislead one. As an aid in determining what has happened to the body both before and after death these foreign substances are often of very great value.

Such things as indicate occupation are always significant.

Certain unusual discharges from the body may be regarded as foreign substances when found. Blood, vomit, urine, feces, and other substances that may come from the body may have come from some other body. They may be recent, and may have come away before or after death.

FIG. 70.—BLOODY FOAM FROM LUNGS DRIED ON FACE.
The dried foam between the lips retains its character. It was reported that this man was bleeding from the ear; it is quite clear how the blood reached the ear.

Their position, condition, and amount must be considered in determining how much attention to give them.

Position and Posture.—The position in which a body is found after death may assume considerable significance, even in cases that have no medicolegal element. Generally, however, the position is the result of the labors of some attendant who has with more or less skill attempted to properly "lay out" the body. This attempt is almost always easily perceived and should not mislead one.

There are quite a number of things that may happen to a body after death which are not unlikely to confuse or mislead one who is not thoroughly alert.

Efforts at resuscitation, aside from marks produced, entirely change the position of the body. Detectives, police, relatives, friends, medical examiners of various sorts, all rush in and change the relations of things,

and seldom have any clear recollection as to what they did. Undertakers have certain routine procedures, such as fastening up the jaw, straightening the fingers and limbs, elevating the head, rubbing the face.

In addition to these routine matters, there are many accidents that occur in the handling of the body, specially in confined places. Before one draws conclusions regarding the position or posture of a body one must be reasonably sure it has not been disturbed.

Supposing we are sure that the body has not been moved, or that it has been moved carefully and without accident, then we can begin to study the significance of position and posture.

The first thing to note is how the body was supported, whether on a flat surface or on an uneven one, and whether it is fully or only partly

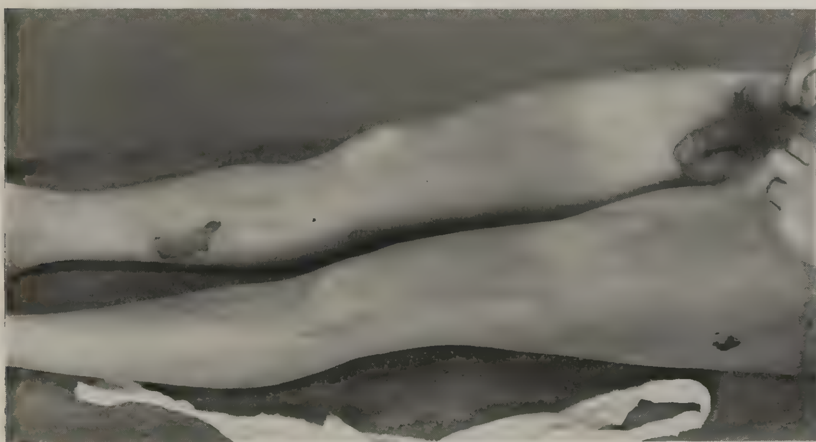

Fig. 71.—Flagellation.

This man died of opium-poisoning, and the attempts to arouse him left these characteristic marks on the thighs. *Hot-water bottles* were applied to maintain temperature, and characteristic marks are seen on the right leg and left thigh. *Fingers* show contraction of cerebral irritation.

supported. Gravity acts most decidedly on the parts of the body, and the expression "dead weight" is very expressive to those who have had much experience in handling bodies—dead or alive. Gravity is restrained and prevented from producing results by many happenings. These postures, that do not signify what they appear to, constantly mislead the unwary. Thus, a man sinks to the floor, his heel has caught on an obstruction and his leg is bent sharply. The picture is the same as if he had a contraction of the leg. Or the arm falls so that the elbow rests on some object and the forearm is in a plane perpendicular to the floor. The picture suggests some purposeful act, or if it be the left arm, the hand may rest against the region over the heart and suggest that the man died of angina pectoris. The position of the body varies enormously in persons who have fallen from a standing position, depending on the degree of relaxation or rigidity, or of the distribution

of these, and on the surroundings; also on the posture the body was in just before the fall.

Falls that are due to apoplexy or other brain effects frequently are toward the opposite side of the body from that in which the lesion exists. Drunken men are apt to fall forward if in the semirelaxed state, or backward if very drunk but not yet relaxed. The resulting injuries may cause death or be entirely independent of it, even where the man lives long enough to develop some reaction to the injury so received.

Falls from heart failure are seldom made with the body stiffened unless the person was moving. Not infrequently it is necessary to

Fig. 72.—Note the marks on the forehead and nose. These are characteristic of violence done at the time of death and became clearer after a few hours by the drying out of the injured skin. They are produced by the death fall. I have used the whole picture because it shows the value of the view from the head end. This splendidly built young man has many features that would interest an artist—shoulders, chest, and hips, but specially the feet. The feet are clearly not American and have not been ruined by the fashionable American shoe. This body was of an educated foreign adventurer and criminal who was never identified.

consider carefully the amount of injury done by a fall before the position can be interpreted.

The position of a body that has fallen from a high place usually offers such difficulties that only experience and great care will enable one to reason with any degree of assurance, and one should be cautious not to speculate carelessly or without first studying minutely the whole place where the fall occurred, as well as the position of the body and the injuries received.

Fainting spells are usually associated with relaxation. Epileptic or other convulsions often produce projectile falls that give characteris-

tic postures if the person dies without further movement, and if such further movement takes place the picture differs enough from ordinary positions to be of material help in the study of the case.

Aside from the gravity effects, or those which result from the tendency of the part to fall or slide until it is supported, there are a number of postural causes. Clothing is not infrequently responsible for certain modified positions found. Muscular action before and at the time of death may cause a part to be retained more or less firmly in some peculiar position.

Postmortem muscular action is more common than is supposed, and is probably at least in part due to irradiation of death currents. These are apt to cause the bending in of the thumbs, and not uncommonly the tongue becomes contracted, though one sees it relaxed at times. The abdominal walls may be very tense and the muscles highly contracted. After sudden death, as in drowning in cold water, the testicles are apt to be retracted strongly and "goose-flesh" is common.

Where there is some nerve irritation, as in apoplexy, the contractures of the various parts are not uncommon. A number of times such contractures have indicated at a glance the nature of the case. The relaxation of the paralyzed side is more apt to be noted by the clinician than contractures. All forms of cadaveric spasm, where the contraction of life has passed into rigor, give interesting and generally important data.

Postrigor changes occur after rigor mortis has passed off sufficiently to allow of motion of parts actuated by either gravity or any other force. The parts are apt to yield to these forces provided there is nothing to prevent it. Thus, the hands will fall if the skin has not dried or the gases have not accumulated.

The production of gases under the skin will, if they are confined, produce marked postural changes of the mobile parts, which will change again as the gas escapes. The decomposition changes are rather carelessly discussed and the results would be ludicrous if they were not at times tragic. To see a court of law entirely carried away by some charlatan who is proving the commission of a crime by means of some simple decomposition effect is funny, if you can forget that some poor creature may get hung as a result of it all.

But when an "expert" deliberately tries to help to hang a man by declaring the position of the tongue, which was a very ordinary one in dead bodies that have undergone decomposition, to be proof positive that the person was strangled, then we have a sense of horror, because such a prosecution is nothing less than an attempt to commit murder.

Facial Peculiarities or Expression.—When medicine was less given to fads of the hour the face was studied and with great profit.

At the postmortem we should habitually study the face with great care in all cases, but specially is it of importance in those which are in any way dependent on chemical conditions by reason either of extrinsic (or exogenous) poisons, or of endogenous poisons or abnormal amounts of normal constituents. These chemical disorders are rapidly taking their

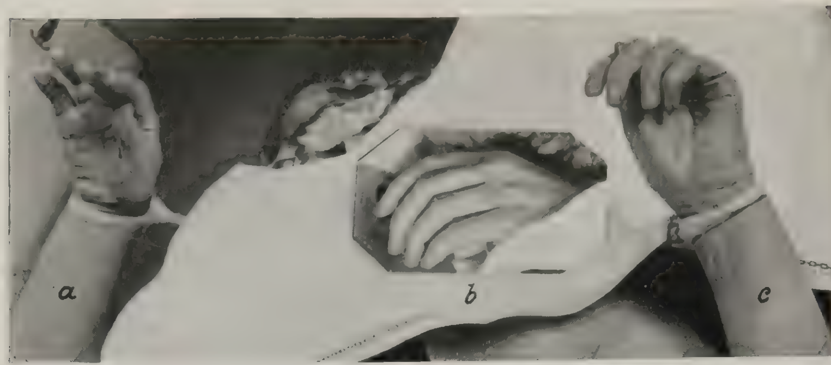

Fig. 73.

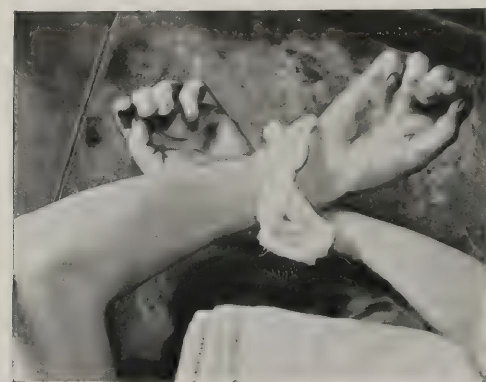

Fig. 74.

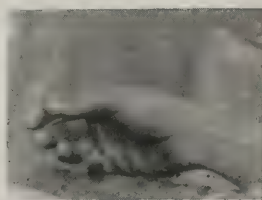

Fig. 76.

Fig. 77.

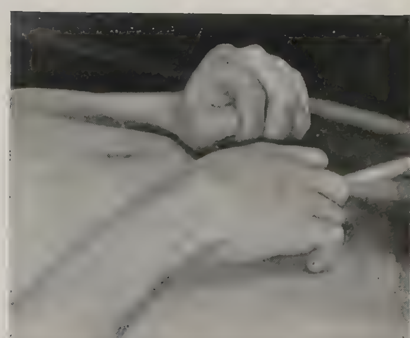

Fig. 75.

Fig. 78.

Figs. 73–78.—These Figures Show the Position of the Hands and Fingers After Death.

Fig. 73.—*a* is the right hand flexed at the wrist; the fingers are pulled fairly straight by the tension of the extensor tendons, the muscles being fixed in rigor. *b* shows the left hand from the ulnar side; the fingers are half bent, as were those of the right hand before it was flexed; *c*, the left hand slightly extended, showing how the fingers are bent by the tension of the flexor tendons. The thumb is between the fingers. These positions can be

place in modern medicine, and the face is wonderfully sensitive to the changes produced by them.

The *muscles* of the face, while usually relaxed so as to give a peculiar character to the face of the recently dead, may at times retain a very striking expression, as is seen in hemiplegias, acute abdominal conditions, and many poisonings.

The *bones* of the face give an index of developmental factors that are associated with inherited tendencies to certain types of disease as well as of various nutritional conditions.

The *nutrition* of the face and its parts gives direct information regarding the metabolic status of all the vital organs—heart, liver, stomach, kidneys, lungs, and internal glands and brain.

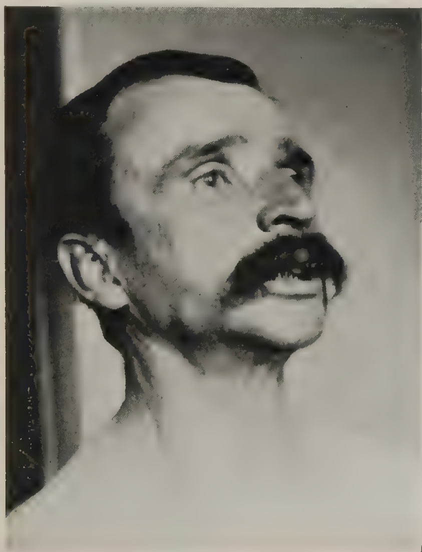

FIG. 79.—EXPRESSION IN TETANUS. (Courtesy of Dr. E. A. Schumann.)

Wasting or fulness of parts or of the face as a whole are very generally recognized as indices of bodily condition, but the art of interpreting postmortem findings demands a systematic study of the relations existing between the appearances of the face and disease.

As *an index* of pathologic conditions, it is surprising what a wide range of these relations exists, and this is more or less generally recog-

easily produced after rigor has fixed the muscles by so moving the bony units of the hand as to cause tension on the appropriate tendons. In this case the contraction of the muscles of the forearms was symmetric in spite of the appearance of the hands. This illustrates how grave errors of interpretation arise.

FIG. 74 shows nearly symmetrically contracted hands; the contraction is slight and was due to brain irritation. The left hand is a trifle more flexed than the right. Note the positions of the two thumbs.

FIG. 75 shows marked symmetric contraction. Note the sharply bent thumb.

FIG. 76 shows normal position—often assumed in life.

FIG. 77 shows how gravity has acted after death relaxation.

FIG. 78.—A normal type from the side, similar to Fig. 76, but falling differently.

nized if not yet part of exact science. Aside from the effects already noted as occurring in disturbances of the vital organs, we find that hemorrhages, asphyxias, poisonings, septic conditions, cachexias of malignant disease, physical violence, pain, mental states—all affect the face more or less even after death has obliterated active expression.

What has usually received more attention but deserves less is the group of purely local affections, such as local palsies, injuries, or diseases. These are not likely to be overlooked.

Asymmetry is an extremely common and often very marked characteristic of the criminal, and is usually found in those that are criminal by reason of defect or disease, but it is by no means limited to the criminal classes nor to defective persons, and it is often modified by local disease. It should always be observed, and one must determine in each case whether to stop to study it carefully.

Color changes group themselves naturally into pallors, increased color, changed color. It must always be remembered that vasomotor spasm may pass into cadaveric spasm, and one may find a pallor in opium-poisoning or other brain lesion that is different in kind both as to cause and appearance from the pallors of anemias.

The pallors of anemias vary greatly. Generally the skin is more translucent than in vasomotor constriction, and is apt to be more yellow. Yellows are generally very suggestive of disease, though occasionally one might mistake the olive skin or a coat of tan for pathologic yellows. This ought not to be common, because one is due to pigmentation, while the other is a condition of the tissues with special relation to the circulating fluids.

Physiognomy.—While there has too frequently been a tincture of charlatanry about this subject which has often disgusted good men with the whole affair, no wise person can afford to neglect the careful study of the principles of biogenesis that underly types or the reasons why certain types are prone to develop certain diseases.

The chemical atmosphere or medium in which the tissues live is clearly different in the well-known types, and it cannot be possible that this is dissociated from the manifestations of diseases that occur in these types.

If we do but remember that normal tissue as well as pathologic structures are, of necessity, conditioned by this chemical medium just as surely as that bacteria grow differently in different culture-media, we will perhaps be carried away from the purely mechanical explanations that have always been so displeasing to thoughtful minds.

If we remember that normal structures develop in a sort of culture-medium or soil, and that all biology goes to prove the influence of soil on the development of structure, we will grasp more readily how significant are the different types, and how intimate is the relation between the chemistry of type and immunity. Practical experience bears out what we know should occur so fully that we have no excuse for continuing to regard idiosyncrasies as a mystery, but rather should we include their orderly study in our routine practice. One does not find

atrophic gastritis in a person with large thick lips. Nor does one give atropin in large doses to a person with yellow hair or cap the teeth of persons with red hair.

The reason why "what is one man's meat is another man's poison" must be reckoned with in a rational way along scientific methods of study of the types.

Evidences of trade or occupation are of value when there is any clearly established relation of the trade or work with disease. This is an enormous subject involving the whole of modern industry, and can only be indicated at this time.

Fig. 80.—Marks.

The *lividity* is seen to be irregularly distributed in patches more erratic than usual; the man was accidentally electrocuted. A *brush burn* is seen on the side, caused by falling after death, and there is no reaction. Fortunately, this appears on a white area, resulting from compression of the skin after death. A similar postmortem mark not, however, rubbed is seen on the right arm. An *electric burn* is seen on the wrist.

Many forms of occupation give callous spots; not a few show contractures; some, hypertrophies. A long list of substances that influence health would include all forms of dust or particles, whether inert or actively detrimental, fumes, gases, and other chemicals, as fluids or solids or in solution.

Occupations may be confining simply, or may demand absence of light or air, or may give rise to neuroses, or may be dangerous by reason of the risk of physical injury or infection. Whatever marks are found anywhere on the body, but specially about the hands, should always be carefully observed, and if the case warrants it they should be thoroughly investigated.

I am so frequently called on to investigate such cases where the clinicians have not been alert in these matters, and the diagnosis has

been missed, that I am very sure that more attention should be paid to the whole subject of occupation as a cause of disease, and the signs of such occupations both in the living and dead, as well as the degree of development of such signs.

Marks on the Body.—This matter is so obviously a part of the routine examination, and is so generally recognized, that it only remains to give a few cautionary directions. The great majority of marks one finds are of no significance whatever in so far as the postmortem is concerned. Scars of surgical operations or from epilepsy, or from fights or occupation injuries are the chief exceptions among those caused by violence.

Scars of ulcers, chancres, small-pox, or serious skin diseases always require consideration, but we are far too prone to explain everything we see as sequelæ to a chancre. Doubtless alcohol and syphilis are responsible for many conditions, but the tendency to forget what little physiology one knows and attribute, often absurdly, all findings to these two, savors more of the menstruating sex than of true science. In general, it is proper to observe everything, but to study only what we have just reasons to consider significant. The danger is evident. The lazy, the ignorant, and the incompetent soon become nihilists, and fail to see the significance that belongs to findings, while the unthinking plodder laboriously stultifies himself and his work by accumulating meaningless details.

Discolorations.—Occasionally the surface of the body is stained by some foreign substance in such a way as to simulate abnormal conditions, such as bruises, purpura or skin diseases, or some general disease giving rise to surface color changes. Workers in dye-stuffs, copper, or industries that employ chemicals capable of giving color reactions are apt to show skin staining.

Clothing is very apt to give up its color to the body, and any one of large experience will recall cases where one could easily have been misled. Cosmetics and hair-dyes of various sorts have produced very striking results; local remedies frequently cause stains. Decomposition colors at times become so vivid that one must suspect some foreign substance. I recall a case of very rapid decomposition that became so vividly green in less than two days that every one was convinced that some poison had been administered, and only the most careful study of the case showed the color to be entirely due to decomposition.

One who is called on to study decomposing bodies can only arrive at just conclusions by a thorough study of the whole surface, in order to judge whether the distribution is such as would indicate decomposition, violence, exterior staining, or poisoning, and it is often necessary to cut or scrape a number of places to determine the condition of the tissues.

Raised Marks.—Owing to the general changes in vascularity of all organs and tissues after death one must be careful not to underestimate a swelling found in a dead body. Where new tissue has been formed, and is the chief constituent of the mark, there will be little change.

If the mark is highly vascular it may appear clearer if in a dependant part of the body after the blood has begun to settle, but if it be on the upper part the blood may settle out of it almost entirely, though this is by no means necessary. Edematous areas vary greatly as to the changes they show after death. When large areas have become "water logged," or boggy, by the leaking of fluids into the tissues, the change is less marked, and after decomposition has set in such a watery condition is commonly found, specially where there is high tension in the body cavities. Old scars composed of fibrous stroma often become more clearly apparent.

In skin diseases, as erysipelas and urticaria, the swelling usually is greatly diminished and may entirely disappear. I have seen cases where the lesion had entirely disappeared, so that without a clear and reliable history one would be sadly confused or seriously misled. One case of meningitis following erysipelas caused me much trouble before it was cleared up.

Depressions are generally produced after death by reason of pressure of some object, such as clothing, supports, objects laid on the body or otherwise caused to press upon it. The loss of elasticity which gradually takes place after the death of the tissues makes such marks more permanent and striking, and leads to overestimation of the force used in their production. This loss of elasticity, however, may have begun as a result of disease before death, or, on the other hand, the elasticity may be retained for a long time. In the swelling of decomposition marks are frequently produced by objects that caused no compression in life or at the time of death.

Holes or pits resulting from diseases which leave depressed marks are apt to change less than elevations, but if the disease was still active at the time of death they follow the rules already given.

Injured tissue, whether the injury was by violence, poison, heat, or disease, shows a greater tendency to both elevations and depressions, and it often becomes a matter of considerable skill to determine the significance of the injury and of the mark.

In studying either elevations or depressions it is best to determine the resistance to compression, either by the finger or an instrument, and, if needed, to open the spot and observe the tissues and vessels.

Wounds.—Hurts or *injuries* will receive special consideration later, but for the present purpose it is well to consider briefly such as will be found in routine examination where they are not important. Surgical wounds are constantly met with at the postmortem, and should be studied from a number of points of view:

(1) Why were they inflicted? The diagnoses made before such operations may have been correct, and we can generally suppose that there were symptoms indicating the need of the operation, all of which are vital to our study of the case.

(2) When were they made? This may not be easy to answer, and at best only an approximation may be made in many cases, but it is important because it helps to solve the problems of the cause and

sequelæ of conditions, the power of repair, and the surgical problems involved.

(3) What is the effect? The effects of loss of blood, surgical shock, or infection are all important, but too often neglected parts of our problem at the postmortem, but the larger problems of the effects of such operations as removal of organs or of parts on the physiologic activities of the body are generally lost sight of entirely. For years special ablations are done before surgeons are taught to hold their hands until they know what functions they are meddling with.

Various hurts can be inflicted by the physical forces, such as heat, light, electricity, or dynamic force, and their position, shape, size, depth, and seriousness must be at least provisionally determined before one can pass them by. Time after time have I been called to examine bodies where serious injuries have been passed by, either through ignorance or misjudgment, and not infrequently have I been called suddenly to examine some trifling mark that has been wholly overestimated and incorrectly interpreted, and not rarely have these marks been inflicted after death.

A carbolic acid burn may be regarded as a skin disease, or a trocar puncture as a gunshot wound; a tumor for a fracture or the reverse; purpura for bruises; blood in the ear from a nosebleed for a fractured skull; the mark of a tight collar for strangulation. The mere enumeration of errors I have met with would fill a chapter. Therefore I am impressed with the importance of alertness in the examination of all external marks, and the need of a good judgment aided by clear perception regarding physical and pathologic causes and physiologic reactions.

Interpretation of Marks.—The age is often important and often most difficult because so little has been made available in the literature on this subject. In general, it can be said that it is safer, in attempting to judge of the age of a mark, to first study the particular body, and not attempt to say that a mark is so old because of some general average laid down in relation to such marks. Thus, a bruise may swell considerably in a few minutes in one person, when an equally severe injury may give no bruise or only a slight late swelling in another.

I have seen a boxer's eye closed in an hour, black the next morning, and well in three days, while another man with a different type of skin will be very much slower in reacting. Where several lesions occur in the same body the reaction will depend on the location. The judgment as to the severity of the cause must always be governed by the peculiarities of the subject. This is best illustrated by the different effects produced in different persons by the stings of insects, where the cause may be the same as to amount and virulence, but the reaction varies from nothing to the most extreme degree of swelling, inflammation, and systemic disturbance. So with regard to diseases and injuries, the peculiarities of the individual must always be studied.

There are certain general matters which belong just as much to the interior as to the exterior that are usually treated under the exterior.

Most of them require the full study of the body before there can be a final determination of the conclusion.

Age.—In this matter a good guesser is generally more likely to be right by instinct than the man of science. Wherever possible avoid the necessity of estimating the age for record, but for study always judge of it and compare the conclusions with the history obtainable.

Sex is rarely in doubt. The problems of sex are chiefly those of pathogenesis.

Size.—The determination of the various dimensions of the exterior are of some value in life, but at the postmortem the relation of the size of the body and the bulk of the organs is the chief problem, and this is a very special line of work that belongs to mensuration and anthropometry.

Development.—The study of this from the outside alone hardly deserves mention, but, when taken in connection with that of the organs, it becomes one of the most important helps we have to an insight into the true inwardness of a case. The physical condition as to nutrition and the local and general structural peculiarities must be observed more or less in detail before opening the body, but the conclusions should not be drawn until after the dissection has been completed.

Type, or characteristic, has too often been separated into two unrelated studies. The study of the color of the hair and eyes and skin cannot properly be dissociated from those internal organs that produce the substances from which the tissue pigments are made. This holds for all characteristics, and it is as unwise to consider trophic lesions of the skin, hair, or nails apart from the nervous system as it is foolish to separate jaundice from the study of the liver or acromegaly from the pituitary; nor is this any less desirable and necessary where the connection between the marks noted and some internal condition has not been established. It is rather more desirable that new relations should be established that are at present only reasonably probable. Here as elsewhere, it is but a sorry mechanic that takes things apart without understanding the significance and relationship of the parts to each other, and to the whole as he proceeds.

Signs Found On the Exterior.—The exterior may furnish many clues which must be run out during the examination of the interior or by subsequent investigations. These clues are seldom final proof of a condition or disease, but rather are they warnings to be on the alert, though at times they constitute the main proof of the disease.

Thus, jaundice tells us to study the liver, acromegaly points to the pituitary, and exophthalmos to the thyroid; bronzed skin, to the suprarenals; baggy underlids, to the kidney; chlorosis, to the blood; pimples, to the intestines; asymmetric contractures, to the brain; but none of these signs tell us the nature or extent of the disorder except in a very general way, and one may be misled very easily unless the greatest skill and caution are used. An excellent example is seen in a notable text-book on medicine, where a picture of Addison's disease was reprinted through

the various editions, but, on making a postmortem, no disease was found in the adrenals.

To point out the limitations and dangers attending the interpretations of signs is, I hold, very different from belittling them, for personally I am constantly observing, studying, and relying on them, only I try always to avoid going beyond the proper limits in reasoning from them.

Things that are insignificant when taken by themselves often tell a very large story. A few little hypodermic scars on the left forearm may give the true clue to a death where it was not suspected that the habitual use of opium played an important part. A blueness of the lips and a suffused face may arouse a suspicion of headache powders, which, had it been noted by the clinician, should have prevented him from giving a finishing dose of a coal-tar derivative. A little fine foam on the lips or in the nostrils will almost always indicate a brain condition causing edema of the lungs, but whether it was due to kidney, heart, or poison or injury will remain to be determined. Still it is very valuable to have this proof of brain complication. Purpuric spots on the surface mean some chemical disorder, but whether it is some obscure disease, some intense infection, or some profound intoxication we must determine. Evidence of pain, as seen in facial expression, stiff belly wall, or drawn limbs, is not to be passed by because it may mean one of many things, such as perforation in the belly, some form of colic, irritant poison or injury, or may resemble tetanus, hydrophobia, strychnin-poisoning, or mental disturbance.

Eruptions on the skin are always significant, whether they constitute the whole evidence of the disease, as in small-pox, chicken-pox, or skin diseases, or are secondary manifestations of internal diseases, or of general infections or of toxemias. Carbuncle is apparently a very simple thing, but the "seal-ring" carbuncle of anthrax is not infrequently overlooked, and, whether we have the opportunity of making or having made a bacteriologic investigation or not, we should not forget that an actual culture in the tissue is quite as interesting and worth study as one in a laboratory, because it not only helps us to understand the disease-producing agent, but it gives us, what we can get in no other way, an insight into the tissues as a culture-medium, which varies under certain conditions, which conditions constitute an important part of the basis of therapeutic measures. Lesions of this sort have still another interest, in that they often show how the disease began and progressed. Though the significance of the distribution of skin lesions has received little illuminating study, the matter cannot always remain in its present unsatisfactory condition.

Asphyxia generally shows external signs, as do many of the other blood-poisons, such as carbon monoxid, chlorate of potash, cyanids, carbolic acid.

Anemias, whether of exhaustion of the blood organs or from hemorrhages, give signs which, when taken with the nutritional indices, give us rather definite working hypotheses that will materially help us to rationally plan our further work.

Signs of injury, such as of fracture, may be easily overlooked or misinterpreted, specially where there are no marks on the body. A slight rotation or shortening can easily be interpreted as due to position or posture. The extravasation of blood under the skin is a very large and difficult field where errors are constantly being made. The blood travels easily through the tissues of the old and the debilitated, and may "point" at a considerable distance from the starting-point.

Trophic lesions are wonderfully instructive when studied in connection with their cause and history, as well as their extent and intensity of development, and when compared with healthy parts.

Evidences of treatment are of importance, as showing where the symptoms were or what the diagnosis was, and often the age of the lesion. All sorts of appliances used by persons, either under supposed skilled advice or in a more or less amateurish way, are found on the dead—plasters, bandages, braces, splints, trusses, supporters, blisters, ointments. Each tells its own little story.

It is curious how much more accurate is the story of a plaster than that from the person who placed it as to the location of the pain. Several times I have determined before cutting that there was a thoracic aneurysm from an old plaster mark on the back, though the clinicians who removed the plaster failed in their diagnoses. Every evidence of treatment, whether mechanical, thermal, hypodermic, or by application, is to be given recognition by at least a passing view.

The reckless use of hypodermoclysis, or injection of saline solutions, is always a matter for serious thought at the postmortem. In case after case one finds this treatment given where the damage is only too evident, but when the pathologist describes the findings which resulted from such doings without mentioning the fact of the injection his notes need editing.

The **apertures** leading into the body belong equally to the exterior, to the interior, and to special investigations, and a preliminary survey should always be made to determine their condition, not simply as local manifestations, but as possibly associated with things to be looked for in the interior. The mouth and nose are specially important, because many serious infections gain entrance through them, and not infrequently the local findings are essential to the proper interpretation of the case. The ear is not rarely associated with brain infection and injury.

The **regions** of the body have a unity that almost gives them the importance of organs, and certain areas are so linked by chemical and nervous bonds with parts of the interior that one cannot afford to forget the significance of such areas.

The regions, apertures, the skin and its appendages will be taken up for special detailed consideration.

Landmarks.—For purposes of locating and describing findings one is compelled to use these, but owing to the wide personal variation in different subjects it is often necessary to locate more by proportion than by direct measurements, and always to use several points of reference.

THE DISSECTION

The body being in as good a position as possible for ease and thoroughness in working, and being suitably lighted and the exterior having been examined, we are ready to explore the interior.

PRIMARY CUT

Standing on that side of the body which corresponds with the hand that is to be used in cutting, which is usually the right one, a clean cut is made from the suprasternal notch to the pubis, avoiding the umbilicus by slightly curving the cut to either side. This cut may go through to the sternum above and the peritoneum below.

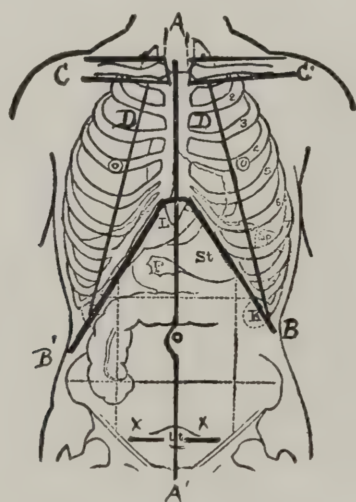

Fig. 81.—Cuts in Opening Body.

A–A'. Long median incision from suprasternal notch to pubis. *B–B'*. Line of separation of attachment of abdominal wall to ribs. *C–C'*. Cuts to free the clavicles. *D–B*, *D–B'*. Line of section of costal cartilages. *x–x*. Transverse cuts in recti muscles.

The axis of the knife being at an angle of about 45 degrees to the surface will give the best general effect. The edges of the cut are then grasped by the free hand, and the knife, placed flat or nearly parallel with the surface, sweeps over the surface of the ribs without becoming engaged by them. The flaps are reflected to a point beyond the junction of the ribs and cartilages. Whether to open the chest or the belly first is a debated point, and where any reason exists the plan of proced-

ure must be made to conform with what is desirable. In ordinary routine work I can see no reason why the chest should not be examined first, while the two are opened at the same time.

OPENING THE CHEST

This is facilitated by dissecting the large flaps well back on the sides, which may be done extraperitoneally or by going through the whole belly wall, and then cutting away the attachments to the lower margin of the ribs.

Practically the simplest and quickest way is to continue the primary cut through the peritoneum, and dissect the outer chest and belly wall as one flap from the bony chest wall. This is done by cutting down on the right side and up on the left. Should the belly wall be contracted or tense, it may be desirable to cut the peritoneum and muscles from within outward, at right angles to the primary cut (Fig. 81, x–x), being careful not to reach the skin. This gives greater freedom and easier view. The two flaps being stretched well out to either side, the knife firmly held over the outer end of the second costal cartilage, a firm, well-controlled stroke is made to cut the chest wall to its lower edge. Only where the cartilages are ossified will it be necessary to resort to other means of cutting. If the cartilages are hard I place the free hand over the knife-holding hand and thus gain greater power.

By proper control and holding, the danger of cutting the contained organs is avoided. Where the cartilages are very firm the use of the straight saw is necessary. If one is afraid of the knife, or has not developed facility in its use, one may resort to shears.

The lower edge of the sternum is grasped firmly with the free hand and moderate tension exerted to raise it slightly, while the knife is made to pass very close to the inner surface of the sternum, with the blade quite flat against it. By grasping the left angle of the sternal mass and cutting toward the right side of the body with a smooth, shaving motion, always keeping the knife flat both from edge to back and from point to handle against the sternum, the tissues of the diaphragm and mediastinum will be readily cut away. When these have been cleared away as far as the first rib, raise the sternum so that it separates in the region of the first interspace and bends or partly breaks. This is much better than cutting out the sternal mass, as is generally directed, because of the very undesirable hemorrhage which generally takes place from the internal mammary vessels, and is very apt to take place from the injury done to the great veins that are often opened in dissecting out the upper end of the sternum, which hemorrhages are entirely unnecessary and often hard to control, and may be so great a source of confusion as to be more than annoying.

If during this process anything is found that demands a change of plan, there should be no hesitation in making it, whether it be modifying the manner of removal of the sternum or abandoning it entirely for a resection of the ribs.

The picture presented on laying back the sternal mass (see Fig. 89) will include the lungs on either side and the mediastinal mass, with the

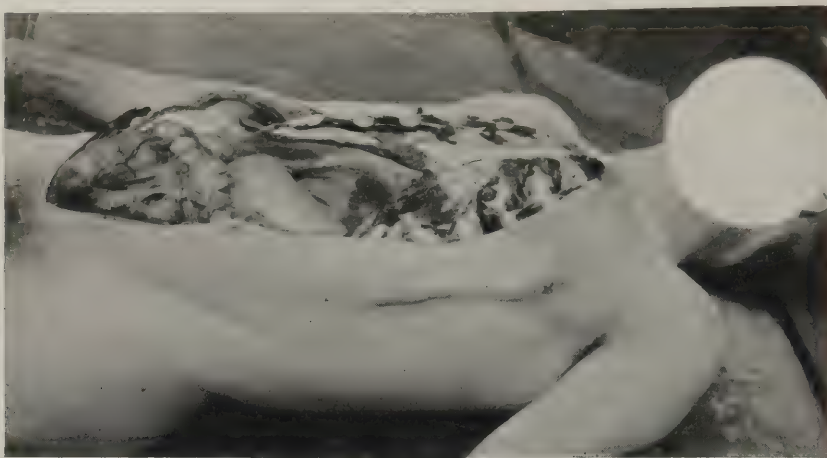

Fig. 82.—Series I, A. Thorax and Abdomen.

The primary cut is made, the costal cartilages severed. The organs undisturbed. The stomach distended with gas. The omentum thin, long, and normal for a young healthy man.

pericardium in the middle or to one side; below these the edge of the base of the diaphragm. In the belly region the organs were observed as they lay while we were cutting the sternum away from the diaphragm

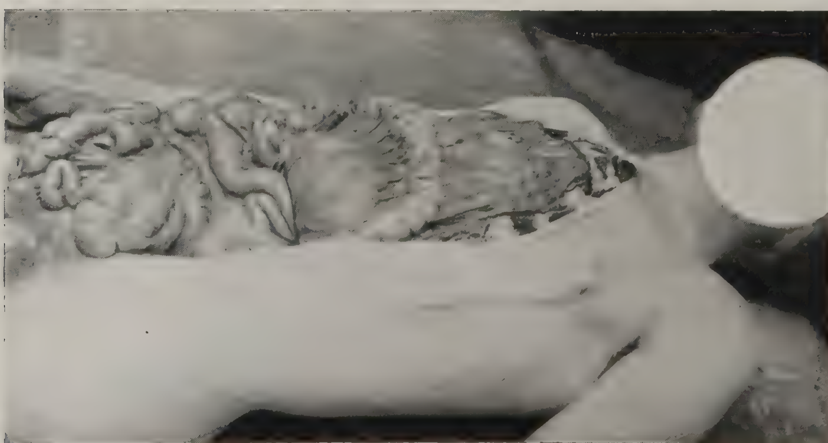

Fig. 83.—Series I, B.

The omentum lifted up, carrying with it the colon, the small intestine laid to the right side. The head of the colon distended with gas, by pressure on the ascending portion, is raised. Note the relation of the stomach to the colon.

if the primary cut was extended through the peritoneum. My reason for not disturbing the contents of the belly until the thorax has been

opened, except for some special reason, is that the dome of the diaphragm can be better seen and judged from above, where the organs

FIG. 84.—SERIES I, C.
The sternum is reflected, showing normally retracted lung. Postmortem position of diaphragm. Colon drawn down with slight traction. Note the gliding surface of liver.

are fewer and more apt to be naturally collapsed, and when handled cause less change in position of the diaphragm and the organs on its other side than if we begin below. In short, it is the natural way a

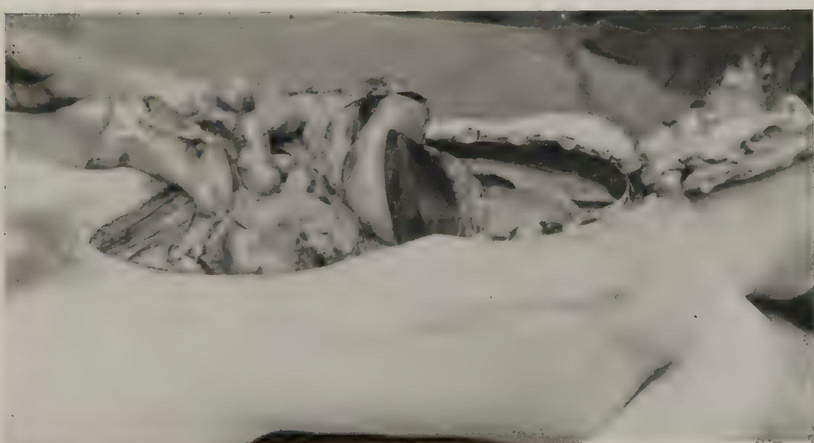

FIG. 85.—SERIES I, D.
The stomach is drawn to the right with the intestines. The left kidney has been laid over with a flap of the peritoneum and we see the posterior surface. The under surface of the head of the colon turned up, showing the appendix.

mechanic would study the machinery contained in the two cavities. Another special reason for examining the general condition of the thor-

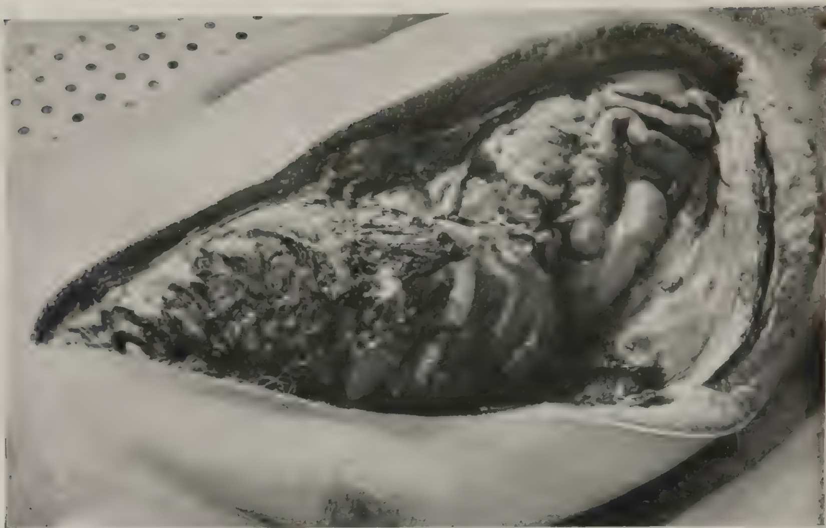

FIG. 86.—SERIES III, A. SHOWS THE PRIMARY CUT WITH THE LARGE FLAP DISSECTED FROM THE RIGHT SIDE.

The photograph was taken from the right side. The light coming from above on the left side gives too much surface reflection. Compare with the other figures of this series, where the camera was placed just out of the line of the light.

FIG. 87.—The large flap on the right side has been reflected so as to display the omentum, which is well developed, and the gut, which shows several discolored loops (postmortem changes). The edge of the left flap is strongly retracted to show an unusually well-developed anterior ligament ("falciform" or "suspensory"), which is inserted near the midline from the umbilicus to the ensiform. The right-hand string passes through the edge of the umbilicus, which shows well its construction, in this case peculiar, being deeply pitted on both its external and internal surfaces. The traction also brings out the remains of the urachus extending downward.

acic organs first is because one can at once form a conception or a picture of the distribution of the blood in the circulatory centers, and this should be done before handling, squeezing, or displacement of other organs has forced blood into the heart and changed the conditions in the great vessels.

In opening any body cavity a certain set of changes will occur, the extent and importance of these changes depending on the contents with relation to gases and fluids and the location and amount of these as well as of the blood distribution. The lungs, if not already collapsed by leaking of gas, will tend to shrink very rapidly on letting in the air, unless their normal elasticity has been lessened, as in old age, or by some

Fig. 88.—Series III, B. Both Lateral Flaps are Seen Reflected.
The blurred appearance of the viscera of the belly is due to the change of tension caused by simply opening the cavity, the movement taking place while the photograph was being taken.

obstruction, such as edema, congestion, inflammation, or fluids in the smaller air-passages, as in drowning.

The chest and abdomen being opened, be sure to *keep hands off* until everything visible has been observed. The condition of the edges of the flaps, including skin, muscles, fat, and blood-vessels, will have been observed during the opening, in regard to tension, resistance to cutting, development, amount of fibrous and other connective-tissue elements. The color, texture, size, and shape of the ribs, sternum, and costal cartilages, as well as their elasticity, calcification, and the spring or motion of the different parts in relation to each other. The bleeding points are watched carefully to gain at once a knowledge of the postmortem

blood-pressure after the cavities have been opened, and a drop or two of the exuding blood should be gathered on a clean knife and spread out on a clean dry area of the skin, and the color and translucency noted at once and at times during the examination in order to determine the rate of oxygenation, and any tendency to become viscid or clot is also noted. The organs are watched during these early moments to detect

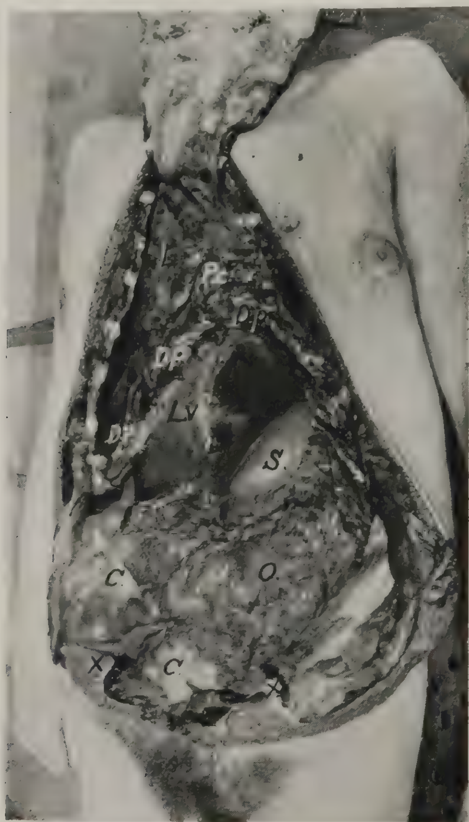

Fig. 89.—Series III, C. Thorax and Abdomen Opened, but Organs Untouched.

The sternum is reflected upward, but still partly attached by the tissues of the mediastinum which are under tension. The lungs (*L.*) are only partly collapsed (showing edema); the pericardium (*P.c.*), which is large and thick, is largely hidden by lungs; the diaphragm (*D.p.*) rises quite high in the middle as a result of the abdominal tension since death; the liver (*L.r.*) is rough and stiff and its surface is hazy; the stomach (*S.*) is distended by gas and compressed by the liver; the omentum (*O.*) is large and quite fat, extending to the pelvis; the colon (*C.*) contains gas, but is largely hidden by omentum. The recti muscles show hypertrophy; the cut ends are seen at x, x.

any changes either in position or condition, as it will often be found that the opening of the cavities will cause marked changes in the distribution of gases and fluids in the hollow organs. (Fig. 88 shows how this took place while the photograph was being taken.)

I have seen the relief of abdominal tension on opening the belly cause a marked diminution in the size of the right auricle by reason of

the reflux of blood into the vena cava, and one can at times produce engorgement of a relaxed right auricle by compressing the unopened belly. The wave produced in the blood column in the vena cava by handling the bowel and mesentery may simulate an auricular contraction in a way that is decidedly discomforting if the body is still warm.

Having systematically looked over the organs presenting in the opening, we are in a position to determine whether to follow the routine or

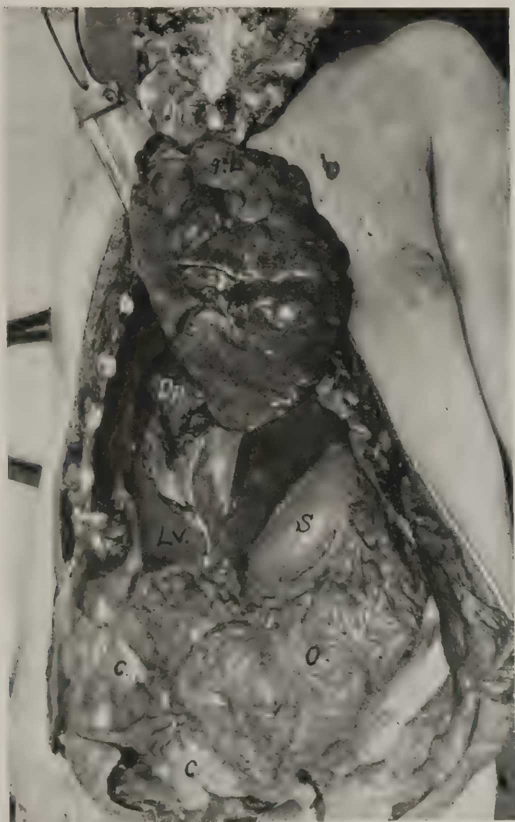

Fig. 90.—Series III, D.

The right lung (*r.L.*) has been lifted out and is supported by the saw. Note slight anthracosis; peculiarities of shape with relation to chest cavity, lobes, and surface markings. The diaphragm (*Dp.*) is seen to be markedly pushed upward in the center, while its attachment at the ribs is low.

change it. The edges of the lungs are now delicately lifted back from the pericardium, and its size, shape, degree of distention, vascularity, translucency, and special condition is observed.

The condition of the lung is noted during this very gentle approach, and all odors observed. Too much stress cannot be laid on the avoidance of careless handling, which always destroys evidence of condition.

Lift out the left lung by passing the free hand with the finger-tips

following the middle intercostal spaces to the spine. Use no more compression than is necessary.

If serious adhesions are found, pass the lungs for a time, at least until the heart has been inspected. The whole left chest cavity is in-

Fig. 91.—Series IV, A. The Sternum, which is Turned Upward, Shows the Attachment of the Mediastinum.

The lungs are partly collapsed. The diaphragm is pushed up markedly by the liver, but is attached very high on the right side. The omentum lies underneath the colon. The pericardium shows the ⊥-shaped cut. The bowel contains considerable gas and considerable evidence of enteritis and colitis. The umbilicus is large and irregular. The flexibility of the liver is shown by the impression made by the colon.

spected and, if necessary, palpated, including the dome of the diaphragm and the spine and posterior mediastinum. The lung is then replaced and the right side is examined in a similar way.

In this examination of the exterior of the lung one must gather the data for an estimate of the development and functional value of the organ and its condition, with special regard to elasticity, blood and air content, massive changes, whether due to inflammation, stasis, infection, vasomotor condition, foreign substances, as anthracosis; and by the gentler pressure needed to bring the parts to the surface one should gain all that is missed by the usual manhandling of the organ.

The **pericardium** is now opened by a small cut made along the edge where it joins the diaphragm, and the contents noted. This small cut may be extended all along the edge before the second cut is made in the front surface. If there is much fluid and it is desirable to save it, a puncture may be made in the left base by knife or a scissors snip, but usually this is not desirable. The ⊥-shaped cut which exposes the whole cavity should be carried up to the very top where the pericardium becomes adherent to the great vessels.

I almost always use a knife in making this cut, but if one prefers to use scissors I do not object. The texture, thickness, vascularity, elasticity, and distention are now fully estimated. The heart is observed without touching. I am in the habit of demonstrating the effect of rough handling on the organs by pointing out the condition of the untouched organs. Then I squeeze and pat and wash them after the too common method, and the change is so marked that even those who believe only what they see are convinced.

In Fig. 180 is a heart that shows a mottling that is a characteristic and a most valuable diagnostic sign, but this mottling had entirely disappeared after the dissection was completed. The vascular condition, as seen in the two surfaces back and front, is always of the greatest importance, and this is only to be observed before opening or removal. The lifting to observe the back may be done by the fingers of the left hand gently slipped under from the apex, or by pinching the extreme tip of the left ventricle. My rule is to handle the heart as though it were a cracked egg until I have decided on its general condition.

Having determined the condition of the surface as to vascular and cavity fulness, and the tone or tension of the walls and the amount of fat, fibrous material, and the muscular development and contraction, pass to the **abdominal** inspection. Note the geography in detail again to see if any changes have occurred.

ABDOMINAL INSPECTION

Cut away the front diaphragm as far as the ribs on the sides and the pericardium above. The omentum is gently lifted and examined as to development, fat deposit, fenestrations, vascularity, adhesions, evidence of inflammation, or special change. The distribution of the coils of gut and their condition must be keenly observed. The odor which is exhaled should have been most carefully noted on first opening the belly, and the rate of drying or color change is often of much value in the study of conditions. Rapid changes in moderately fresh bodies should always

attract our attention, and the cause and relation with the symptoms always studied. I have seen very marked changes in an hour, and in such cases I investigate the blood, the putrefaction in the gut, and the kidneys.

The abdomen contains the great complex food mill, and each part is related to every other part in a peculiar way chemically, and depends on

Fig. 92. Fig. 93.

Figs. 92, 93.—Series II, A and B. Interior of Body.

The attachment of the mediastinum to the sternum; the slight collapse of the lungs; the texture and structure of the omentum; the tension of the gas-filled intestines; the position of the diaphragm, with the liver pushed up by intra-abdominal tension; the pericardium slightly covered by lungs. In Fig. 93 the diaphragm has been cut away so that the liver and stomach are displayed and their relations shown. The lungs have been examined and replaced and show more of the heart after being handled.

the vascular and nervous supplies; and the vascular and lymphatic systems of carriers are the places where changes of function in the gut quickly display evidence of such changes. The examination of the gut in position reveals vastly more than can possibly be found after the slop-

bucket method has been employed. The vessels to and from the gut are differently filled in the different reaches or areas, and this difference varies in each case, and one finds that there is a distinct significance to these variations which can only be determined by studying the mesentery and gut together.

The lymph paths, with their related glands, tell us what has gone wrong, and by the location of these glands we estimate where the process began, and by their size we estimate the degree, and by their condition the severity and duration, of the processes.

Once we sever the gut from the mesentery we have destroyed the only possible means of rational observation of relations of cause and effect.

The degree of contraction and of fulness, the quality of the contents as to consistency, color, odor, reaction, inflammatory products, digestive advancement, putrefactive changes, and direct pathogenic infection—all these must be studied in a natural way by observing minutely the undisturbed gut. Surgeons are beginning to find that they can no longer look on the gut as if it were a piece of tubing. They are finding the significance that attaches to each area. Postmortem workers have still larger problems here. Tissues, like bacteria, differ by what they do as much as they do in morphology, and one can hardly tell what an area of gut has been doing after it has been ripped out, washed clean, and overhandled, whereas one had a reasonable chance of finding out many interesting and valuable facts when the gut, its contents, and its relations were undisturbed.

The sum of it all is, Never allow any proceeding to interfere with the gut as it is immediately after opening the belly until a full study has been made of its exterior and relations.

In making this examination of the gut avoid all rough handling and disturb the contents as little as possible. Handle the whole as carefully as you ought to at a laparotomy.

The loops of bowel may be gently lifted with the partly spread fingers, or the mesentary may be lifted, bringing up masses of loops which can be bent over the side of the belly wall while the other organs are viewed.

Passing the thumb and fingers down between the loops one can easily grasp a large mass of mesentary which holds the loops, and this mass may be held as one would a bouquet, and turned about until the whole has been viewed. Then, by commencing at one end, preferably the lower one, grasping the mesentary with thumb and finger of the right hand, the bowel being in the circle formed by the thumb and finger, draw short lengths through the left hand similarly placed.

A simple alternation of flexion and extension of both wrists will cause the whole circumference of the bowel and both sides of the mesentery to be displayed.

If changes are found by the eye, there will usually be found some glandular condition corresponding. This will be detected by the fingers, even though there is considerable fat. In ordinary cases all the ab-

dominal organs can be brought into clear view and carefully examined and all but sectioned, with practically no loss of blood.

As soon as the distribution of the blood has been determined in all the important organs we may begin to make such cuts as are neces-

Fig. 94.—Series IV, B.

The flaps of the pericardium are drawn aside; the heart is contracted, leaving considerable space; the omentum is very small; the relations of the splenic flexure of the colon are plainly seen; the duodenum is lighter in color than the lower part of the small bowel, as is common in auto-intoxication. The mesentery is injected and shows a few small glands. The mass of the bowel has been lifted to the right side. The relations in the upper pelvis may be seen. (Compare with Fig. 91.)

sary to remove or examine organs. If nothing points to a departure from the routine, we go back to the thorax and remove the lungs by cutting from the diaphragm side close to the lungs.

I find the cleanest and easiest way is to again bring the lung out of

the pleural cavity by the open hand with slightly flexed fingers. The root of the lung containing bronchi and vessels slips between the middle and ring fingers, and the lung can be drawn toward the front and side

Fig. 95.—Series IV, C.

The left lung has been lifted out; shows nearly normal surface, slight areas of congestion, general edema. The heart is turned so as to show its shape during contraction; also the plain on which it lies above the diaphragm and rests on the liver, which is drawn down, and by the way it has bent is clearly soft. The colon has been drawn downward, showing its relation with the stomach and omentum. The stomach is nearly empty, but not contracted, and is markedly injected. (Compare with Fig. 94.)

and head, and the knife passed close to the fingers. Generally, it is better to examine the heart before proceeding with the minute study of the lungs.

It is often desirable to open the heart before allowing any large

vessel to be opened, in order to gain positive knowledge as to the amount and condition of the contents of its cavities. On the other hand, it may be desirable to dissect out the circulatory system, and in that case simple openings for inspection of the contents may be made and then left while the other organs are removed.

Fig. 96.—Series II, C.

The intestines have been laid to the right. The colon detached with its peritoneum. The stomach, which is distended with gas and injected, was laid up and to the right. The kidney with its vessels and the ureter are seen in place. Postmortem changes are progressing rapidly and a dusky purple color prevails. The relation of the kidney to the diaphragm is well shown. The peritoneum has been removed from in front of the kidney and great vessels. (Compare with Figs. 92 and 93.)

While dissecting the thoracic organs the presence of blood is unpleasant and often undesirable. The simplest way is to remove the left lung and bale or sponge out the pleural cavity, and then return to the abdomen, while the blood drains out of the major circulation. The removal of the abdominal organs before their examination is seldom necessary when they are to be studied, but in demonstration work they must be better displayed than is possible in the confined space of

the abdominal cavity; therefore it has grown to be a custom to spread the organs about to a wholly unnecessary extent.

My chief problem always is how best to see with the least possible destruction of relations which cannot be replaced, and in the problem of relations one must include the so-called indifferent tissues. I cannot bring myself to regard the mortar in a house as insignificant, nor can I consider the fibrous skeleton of the viscera as unimportant. In every dissection this should be regarded as far more important than it is usually held to be. Therefore the carving out of the organs from their natural setting and support should be done with greater appreciation of the part which the connective tissues play.

The spleen is the first abdominal organ we remove because it is easy to reach, has few relations, and is in the way, but the removal should be done only after its relations with stomach, kidney, and gut have been noted.

The stomach varies in position, size, shape, vascularity, fulness, relations with surroundings, internal condition and contents, and each one of these factors determines in part how and when it is to be opened or removed.

Where the appearance is of such a character as to point to primary gastric condition it ought to be opened early and before handling has disturbed the relation of the contents and walls. Such handling as is necessary to examine the duodenum and pancreas is ordinarily not detrimental, but where a primary gastritis exists or a poison is suspected, the simplest manipulations and handling must be avoided until a view is had of the interior. This view is best obtained by a small opening on the front surface well toward the pylorus and midway between the greater and lesser curvatures. This being easily closable by ligature, disturbs fewer organs, and is in the least vital part of the stomach, as well as allowing the contents to lie undisturbed in the large sac of the cardiac end.

If something of note is found on examination of the stomach through this window, it may be desirable to remove the organ at once, either with or without ligatures. It should never be forgotten that a ligature causes changes in the coats and lining of a hollow organ. Therefore it is well to avoid ligatures in general unless there is special reason for their use. I have seen ligatures passed blindly, as a matter of routine, practically destroy most interesting conditions, and I am most strongly opposed to careless ligation of the unexplored duodenum. Not infrequently I prefer to remove the major part of the esophagus above and the duodenum below with the stomach. This necessitates the free cutting of the diaphragm and the freeing of the duodenum from its intricate bed. Ordinarily, the stomach requires freeing from the omentum and the transverse colon below and the spleen on the left. Then it can be gently turned up over the liver and the pancreas brought into view. At times it is easier to go above the stomach, using the lesser curvature as a sort of doorway, but often this requires too much stretching of the stomach to be proper.

The liver is perhaps the most deceptive organ in the body, the front surface view being of only moderate value. When the thoracic viscera have been removed it is a simple matter to snip the attachments of the diaphragm in front on either side, and turn the liver over, into the thoracic cavity. The ligaments and attachments and the great vessels may hinder this proceeding occasionally, but the picture of this turned-

Fig. 97.—Series III, E.

The lungs (*l.L.* and *r.L.*) have been removed and laid on chest wall. The heart is laid out on left breast. The liver (*Lv.*) has been turned up and back into pleural cavity, showing under surface and gall-bladder (*G.Bl.*) and the duodenum (*Du.*); the stomach (*S.*) is drawn to the left and upward. The right kidney (*r.K.*) has been uncovered by the removal of the peritoneum and its relations with the duodenum, liver, and diaphragm are seen. The pancreas (*P.*) is seen embedded in fat. (Compare Figs. 88, 89, 90.)

up liver with the gall-duct stretched is generally very satisfactory. The investigation of the duodenum is greatly aided by this very simple trick. It also helps to clear the way for a study of the common duct, the pancreas, and the duodenum. While making the cuts in the diaphragm it will be a very simple matter to observe that organ and the upper surface of the liver, and before tipping up the liver the ligament

running to the umbilicus may have to be cut, though this may be lax or even absent.

During the freeing and tipping up of the liver its shape, size, consistency, congestion, as well as its relations to the viscera, are easily observed, and the way it fits into the dome of the diaphragm and the angles of its surface, all are significant of its vital relations.

The relation of respiration to liver function is always important and often essential to the understanding of the conditions. The alternate compression and relaxation of the liver by the swing of the diaphragm

FIG. 98.—SERIES III, F.

The lungs, above, laid on chest. The heart, turned onto left breast, is seen to be quite peculiar. The liver turned up and back into the pleural cavity. The intestines, lifted to the left side, are well filled. The duodenum is of a dark color from congestion and bile staining, while the kidney above is pale. The pancreas has been freed from its bed of fat and is laid on a strip of white cloth, the head is in contact with the duodenum, the whole is seen to be large and dark colored (congested), its contour shows that it is soft. The large, moderately filled gall-bladder is very long and is seen leading into the duodenum above and to the right of the head of the pancreas. (Compare with Fig. 97.)

plays a great part in the health and in the prevention of stagnation, both of the portal circulation to and of the bile from it.

This overcoming of stasis is a very different matter in a compact liver from that found in a flat, flexible one, and fibrous tissue in the former is vastly more significant than in the latter as a causative factor in disturbances.

The relations of internal architecture must be studied with relation to the surroundings while those various structures are in their positions, as the reconstruction of the liver position is very difficult. The gall-

bladder being brought into clear view, and the duct, being under tension, can be easily examined, and the lower end can be traced down by a few properly directed movements of the knife, generally shearing or

FIG. 99.—SERIES IV, D. THE WHOLE MASS OF THORACIC, ABDOMINAL, AND PELVIC ORGANS HAVE BEEN REMOVED AND IS VIEWED FROM THE FRONT.

r. Right. *l.* Left. *Bl.* Bladder. *C.* Colon. *H.* Heart. *L.* Lung. *Lv.* Liver. *S.* Stomach. *Sn.* Spleen. *Sp.Cd.* Spermatic cord. *Ts.* Testicle. It will be clearly seen that relations are much disturbed by this method. (Compare with Figs. 94, 95.)

scraping in type rather than cuts. The stomach and spleen and intestines being either displaced or removed, the whole length of the duodenum and pancreas can be laid bare by a little similar trimming dissection.

Having completed the examination of the exterior of the abdominal part of the digestive system, a light cut is made in the peritoneum on the

Fig. 100.—Series IV, E. Same Mass Turned Over and Viewed from Behind.

Ao. Aorta. *Bl.* Bladder. *C.* Colon. *I.* Intestines. *L.* Lung. *Lv.* Liver. *K.* Kidney. *S.* Stomach. *Sn.* Spleen. *Sp.Cd.* Spermatic cord. *S.R.* Suprarenal gland. *l.Ts.* Left testicle. *Ur.* Urethra. The aorta has been dissected out, opened, and laid to one side. The bladder has been cut open. The spermatic vessels are seen entering the cord on the left side. (Compare with Figs. 99, 101, 102.)

left side, a little to the front of the kidney, and with care this may be reflected so as to display the kidney and ureter with the adrenals with-

out seriously compressing these organs, and, as they are generally more firmly attached in front than behind, of course they will show their posterior aspects. If any reason presents itself, they may be approached from the front, but this is more apt to be complicated by bleeding. In a similar way the organs can be shelled out as a mass with ease in ordinary cases, specially in young subjects. This enables one to

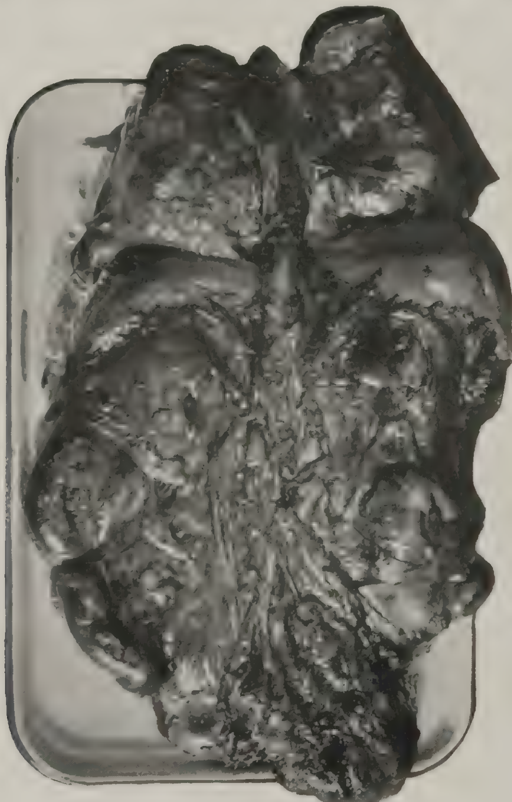

Fig. 101.—The Mass of Thoracic, Abdominal, and Pelvic Organs.

The upper transverse cut is made at the level of the base of the neck. The thoracic organs are stripped from the spine. The diaphragm is cut close to its attachment to spine and ribs. The abdominal organs, including the peritoneum, are stripped from the spine and abdominal wall. The pelvic mass is shelled out by dissecting close to the bones and ligaments. Compare with Fig. 102, where the organs have been uncovered by dissecting off the supporting and fixing layers of retroperitoneal connective tissue. Compare also with Fig. 100. Note the entire difference in type of organs and in blood distribution.

investigate the whole urinary tract as far as the urethra. The right kidney can be similarly removed or laid over in a connective-tissue flap, either before or after the removal of the pelvic mass.

The cutting of veins in the removal of the pelvic mass can hardly be avoided, but the bleeding causes little annoyance, and if the blood distribution has been studied it offers no seriously objectionable complication. The pelvic mass will contain the bladder, rectum, and

certain of the sex organs, and these require to be observed externally and more or less carefully dissected, depending upon the conditions of the case. They can be approached to so much better advantage after the pelvic mass has been shelled out that I seldom think of cutting them in position unless some extraordinary conditions are found. The removal of the organs of the thorax, abdomen, and pelvis as one mass is

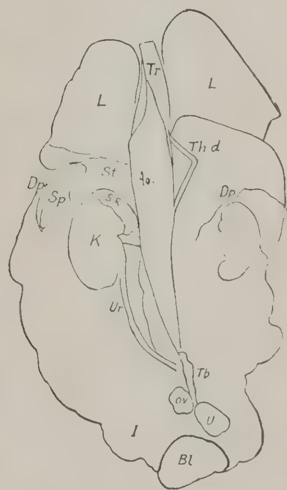

FIG. 102*a*.—*Ao.* Aorta. *Bl.* Bladder. *Dp.* Diaphragm. *I.* Intestines. *K.* Kidney. *L.* Lung. *Ov.* Ovary. *Sp.* Spleen. *S.R.* Suprarenal gland. *St.* Stomach. *Tb.* Tube. *Th.d.* Thoracic duct. *U.* Uterus. *Ur.* Ureter.

FIG. 102.—The aorta has been opened throughout its whole length. The thoracic duct is raised on the hook. The bladder laid freely open. The tissues have not been disturbed on the right side. The forceps are attached to the left tube and exert moderate tension on the ovary.

often desirable, specially when a demonstration is to be made or when certain dissections are desirable. More particularly is this desirable when the organs are matted together by adhesions, or when some disease affects several parts or organs, and greater freedom of access than can be had with the organs *in situ* is an advantage. To do this one may begin at either end or side, but in general it is easier to cut out the sternum and cut off the throat mass well above the arch of the

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aorta, grasp the upper end of the trachea, and pull it forward and downward, freeing the mass from the spine. Cut the diaphragm completely at its attachment to the spine and ribs and the peritoneum well out beyond the kidneys. The pelvis may be freed first or while the mass has been carefully laid to one side.

It is well to lay the mass in its normal position (that is, the front of the organs upward) on a clean sheet or cloth. Though this is not necessary, it is a considerable help, in that the blood is quickly taken up without sponging or spreading and sliding is avoided. It is, of course, only to be done after so much as possible of the geography of the parts has been studied.

Whether to view and dissect from the front or the back will depend on conditions. Generally, one can determine this while removing the mass, as the front has already been observed and the back is observed while the removal is in progress. Where there is no objection to the cutting of the front of the throat, the primary incision may be made from the under surface of the jaw instead of from the suprasternal notch. The skin-flaps being dissected so as to expose the throat mass, and the muscles being cut away from the inner and under surfaces of the jaw, the throat mass with tongue and floor of mouth will be the upper limit of the whole mass to be removed. This allows of a very excellent demonstration of the whole respiratory apparatus, but is not advisable where special dissections of the throat are to be made.

We have, then, three ways of approaching the separate organs:

(1) *In situ*, when they are examined without detachment from their related structures.

(2) Mass removal, when the relations are only partly disturbed.

(3) Commonest and most destructive of relations, therefore least desirable, the removal of organ by organ.

The choice of method will depend on the purpose of the postmortem.

For crude class demonstrations, where only the rudiments are sought to be taught, the morcellation method has the preference; for special dissection the mass method is very valuable, but for study of the whole problem, as presented by a case either of violence, disease, ill health, or for scientific investigation, the more that can be done without destroying data the better; therefore the better work will always be done with the preference for the study of the organs *in situ*, and only as a last resort will they be cut out.

The complete discussion of the organs would involve all of anatomy and pathology as a beginning, but we will take up in the next sections the special examination of the organs under the natural regional groupings: the skin and its appendages, the head, the throat, the thorax, the abdomen, the pelvis, the sexual organs, bones, joints, and muscles.

Whether to examine the brain first, or after inspection of the thoracic and abdominal viscera, or last is a question that must remain open, to be decided in each case. In general, I prefer to open the thorax and abdomen first, in order to observe the distribution of the blood in the vital organs. To open the head without loss of blood is rarely possible,

and at times the flow from the great veins is enormous. This is at times so great as to interfere with the cleanly removal of the brain. When, however, there is much tension in the abdomen, it should be relieved by opening before the skull is opened, otherwise the postmortem blood tension of the vessels of the brain will be entirely misleading.

The findings in the body may be, and often are, of such a character as to make it necessary to open the head before completing the visceral

Fig. 103.—Series IV, F.

The organs having been removed as a mass (see Figs. 99 and 100), the walls of the thorax, abdomen, and pelvis can be fully studied. For this mass removal it is desirable to cut out the sternum: bleeding will naturally occur during the operation. The spinal column can be inspected or dissected. To do this in the lower region the psoas muscles, which are seen clearly in the picture, will be removed. The attachment of the diaphragm is seen to be normal at the back.

examination. A full bladder, edema of the lungs, and congested glomeruli in the kidney, with or without contracture of the extremities, generally point to head lesions. Of course, medicolegal cases require special care in selecting the plan of procedure, but many of them also have something in the history that helps to determine the plan. When in doubt, fall back on the routine of opening the thorax and abdomen, studying the geography thoroughly, and if after that no special indi-

cations are found, proceed to examine the organs as they present themselves—lungs, heart, spleen, intestines, stomach, liver, kidneys, pelvis, and brain.

SUMMARY OF A ROUTINE EXAMINATION OF A BODY

Preliminary.—Permit, history, identity.

Exterior.—Surroundings, clothing, posture, general and detail examination.

Dissection.—Primary cut, opening thorax and abdomen. *Inspection* without handling—geography. *Inspection* with handling—lungs, pericardium, thoracic cavity, diaphragm, peritoneum, omentum, colon, liver, intestines, spleen, retroperitoneal structures, and pelvis.

Full Examination.—Heart, mediastinum, lungs, great vessels, esophagus, stomach, duodenum, pancreas, liver, intestines, kidneys, suprarenals, ureters, bladder, sex organs.

Brain, membranes, circulation, parts. Cord, nerves.

Special dissections.

The closer one adheres to the natural method of following out each system of organs the better. Observe everything, study the special problems that present themselves. Note the significant things and make true estimates of their values. Even when collecting masses of data for series studies avoid neglecting the all-important matter of values and reasons, so as to know whether the case is to be included in or excluded from certain groups, else only blind averages will result.

SPECIAL REGIONS AND ORGANS

THE SKIN

The study of the skin has become a large and more or less clannish specialty which I have no desire to invade, but my observations on the skin of the dead as well as of the living have convinced me of the important relations which exist between skin conditions and the health or disease of internal organs. Some rashes have been recognized as from intestinal disorders, and more will be in the future. But the skin is far more than simply the place where we find rashes. It has its tissue structures and outgrowths, all of which respond to internal changes, both of nutrition and of disease. Being largely a vegetative sort of structure, it responds, first, to chemical changes; second, to vascular conditions; and, third, to nervous conditions. Further, the picture we see after death depends on the manner of dying, including not only the terminal or immediate cause, but many of those conditions leading up to it.

Thus, we see cyanosis when there has been edema of the lungs; this is often coupled with signs that tell us of the cause of that edema; a peculiar pallor or putty color often shows opium-poisoning or severe cerebral involvement, which will generally end in edema of the lungs, but there may be only the sallow color of chronic intestinal poisoning of the kidney, or the baggy eyes of old degeneration of the kidneys; in either case the edema was of immediate cerebral origin, secondary to the kidney lesion. The lungs, the liver, the kidney, the heart, the suprarenal glands, the parts of the gut, and the sexual organs all have more or less characteristic signs that are visible on the skin. Blood conditions, such as anemias and chlorosis, are generally recognized in life by their skin signs. After death these various signs are at times less clear, owing to the changes occurring at death, but enough remains to make it proper to be on the alert while examining the skin at the postmortem.

Many of these signs are part of the common stock of medical knowledge. Some are only recognized by the more observant and specially informed, and some have not yet received enough recognition to be counted as part of modern medicine. We may study the skin as a whole in relation to its nutrition, including texture, fat, glandular elements, hair and nails; with regard to its physical properties, such as tension, thickness, firmness, elasticity, color, vascularity; and in regard to its pathology or lesions, the most striking character is *color*.

Death generally shows a degree of pallor which must always be counted on. This is increased by anemias, either localized in the skin or general. Vasomotor rigor plays such an important part in many cases that it is a marvel that so little is to be found about it in the literature. After hemorrhage the translucent pallor is marked,

and after vasomotor spasm this translucency is generally lacking, though the pallor may be as marked. Profound cachexias, as in malaria and syphilis, give pallors that can often be distinguished even before we find a good amount of blood in the body.

The toxic colors found largely in poisoning in the industries—anilins, lead, silver, carbonic oxid, chlorates, etc.—all give striking evidence that is often the most valuable sign we have to direct our studies. The color changes in blood-destroying processes, whether due to infection or to poisons, are often very striking and generally persist after death.

The relation of the skin to **industrial disease** is often too little appreciated. Thus, in lead-poisoning there are two colors, the very white color in old chronic cases, and the sallow color of lead cachexia. Eminent skin specialists tell me they see very few cases of lead-poisoning. When we consider the frequency of this condition we must conclude that skin diseases are less common in saturnism than the theory of probabilities would call for. This appears to be one of the few exceptions, for very many of the industries which employ deleterious substances have an abundance of skin disorders.

The relation of the **organs** to color changes in the skin are well known—at least a few are. We recognize the hepatic and hemogenic jaundices, and we attribute bronzing to the suprarenal bodies. Coffee and tobacco and alcoholic excesses are often recognized, and sometimes copremia is recognized by the pasty complexion. The removal of the spleen produces a dusky pale purple with puffiness. Localized color changes always require investigation.

Postmortem color changes have been already treated of, but it must be remembered that the often-quoted statements regarding such changes are very far from true. Thus, in regard to the location of the changes, one reads of the green discoloration of the belly as the first prominent change. In case after case I have found color changes beginning in other parts of the body first, and in many cases there was no green changes about the belly.

The distribution of postmortem color changes are very variable and may be misleading. I have seen these taken for bruises very often, specially when maceration has progressed and local decomposition of the blood and blood-vessel walls has allowed the laked blood to pass into the tissues. Postmortem color changes are apt to increase, and may be so rapid that they can be watched. They are by no means confined to the areas surrounding the veins, though this is a very common distribution. These changes depend on the pressure of the blood, on its chemical and bacterial condition, on the surroundings of the body, and not a little on the presence of oxygen. One should always study these skin colors in connection with the coloration of the interior.

Edema may remain or fade, depending largely on its location and character. In extensive edematous swelling, as in the legs, due to heart weakness or to obstruction to the circulation, there is only a gradual settling to the dependent part, but when the skin is tense this, of course, is not possible, and where the edema already has so settled it will change

but little. The edema of inflammation, however, is more apt to disappear. It is possible that what is taken for edema in such cases was congestion, and the blood being in the dilated small vessels would easily drain away. Certain forms of infection give rise to a swelling called edema, but as this changes after death we may suspect that part of the swelling is due to vascular dilatation.

At present we meet with cases where saline solutions have been forced into the tissues. Ridiculous as it may seem, I have heard pathologists describe such deposits as localized edema. Such an error might lead to serious confusion. It should be remembered that the skin varies greatly in its fluid contents. It is not unusual in tuberculous negroes to find a marked excess in the deeper layers.

Emphysema is occasionally met with. The commonest cause is putrefaction. The gas may result from decomposition during life by gas-producing bacteria. At one time great stress was laid on emphysema and its supposed connection with air in the veins. While we must discount much of the literature on the subject, it is possible for air to enter the great veins in sufficient quantities to pass through the capillaries of the lungs and appear on the other side. The presence of air in the tissues after some injury to the lung is a more simple matter, and one finds such emphysemas not rarely when either the pleura has been opened, the lung punctured, or some other part of the air-passages wounded.

Blood is frequently found outside the vessels, either as in bruises, as purpuric spots, or as simple hemorrhagic points. At times it is of importance to be sure whether the blood is outside or inside of the vessels, and, if possible, what the cause for the condition found was, whether it was a congestion or an extravasation. It must always be remembered that decomposition gives rise to transudation.

THE HAIR

The hair, by its color, size, texture, length, distribution, and strength, tells us much that we can obtain in no other way about the general vital condition of the body. The association of red hair of a deep burnished copper type with blood-vessel disease is most striking. I have come to speak of this type as hemic hair. The coarse, sparse hair of gastritis and the fine buff-colored hair of old liver degeneration are very characteristic.

The relations of severe infections to the hair are commonly recognized in so far as the falling out or change in color or texture, but the complete study of the relation of hair to disease has not yet been commenced. One should always be on the alert for peculiarities of color, distribution, size, and quality, and specially should the differences that exist in different parts of the body be noted. What I term the "refrescent type" is one that is most instructive; its commonest form occurs in connection with functional nervous disorders, sexual excess, and tuberculosis, and shows itself by red beard or a tinge elsewhere; otherwise the hair is quite dark. The trophic changes in the hair where the nerves have

been injured are most striking and are well known. The diseases of the hair itself are generally local, though the hair responds to general diseases and to poisons.

THE NAILS

The nails are apparently insignificant appendages, but I find the habitual examination of them most significant and interesting. They share with the hair and the rest of the skin a sensitiveness to chemical and nervous influences that is very striking.

The hard smoker usually has longitudinal ridges on brittle nails. The neurasthenic and neurotic generally have sharp, laterally curved nails, specially on the little and ring-fingers. Cases where fibrous tissue is deposited, as in tuberculosis, show curvation in the length. Serious old brain degeneration often shows fantastic malformations or excessive thinness. Industrial poisonings are often cleared up by an examination of the nails. Fevers and infections which affect the nutritional condition of the skin very frequently leave transverse white marks which give evidence long after of the illness, and help to fix its date and duration, though the rate of growth varies considerably both in different individuals and in the different nails of the same person. Actual diseases may be purely local or a manifestation of serious general disorders; this latter is specially true of syphilis.

SKIN LESIONS

Strange as it may seem, there is a lack of postmortem study of skin lesions, and the available literature is very deficient. To supply this lack, even in a brief and unsatisfactory way, may help some who desire such information.

Skin lesions can be grouped for our purpose into general diseases with local manifestations and purely local disease; with a large class of diseases where the local manifestations which constitute the disease are largely dependent on general conditions.

Causes.—*A*. Physical causes produce a group of effects, from simple redness or its reverse, pallor, to serious congestion, with or without transudation of fluids into the skin or deeper tissues.

(1) Of these, radiant energy, heat, light, *x*-ray, etc., are of common occurrence.

(2) Mechanical pressure or violence, by its various applications, produces abrasions, contusions, hypertrophy, scars, foreign substances, depressions, and swellings.

(3) Sequelæ of a vast variety may follow these.

B. Chemical agents:

(1) Directly on the skin cause stains, irritations, inflammations, erosions.

(2) In the body, give rise to outbreaks of rashes or to discoloration or to many secondary changes.

(3) Organic poisons, either autogenous or parasitic, produce a wide range of skin outbreaks.

(4) Some poisons cause physiologic conditions or signs on the skin that are most important, though not classed as pathologic.

C. **Bacteria** directly in the skin cause, by either physical, chemical, or other physiologic reaction, various skin lesions.

D. The **general diseases** not classed as skin diseases cause many effects, from pallor to purpura, from leukoderma to jaundice or bronzing, and from erythema to trophic ulceration.

It is perfectly clear that certain of these effects may have resulted from one or more of these causes, and as we meet the effects it is of use to us to form some grouping of them that will help us to judge of the causation from these appearances, and we must add to this a most important factor—that of the changes that take place in these signs at or after death. For not a few of these signs entirely disappear and many more are greatly modified. If possible, we must realize how to grasp this series of changes by simple general principles. All these changes are the result of modified physiology of the elements of the skin. Changes wrought by foreign substances are comparatively few, such as silver, lead, bile, which may reach the skin directly through the blood or by external application. Chemicals stain generally by external application.

CHANGES AFTER DEATH

A. Color:

(1) Pallor may be due to general or local causes. It generally increases, but may persist, fade, or disappear, depending on the cause, intensity, and postmortem changes.

(2) Stains usually persist and are apt to become more clearly apparent unless, of course, they are subjected to some chemical action or washed off.

(3) Pigmentation usually becomes more marked.

(4) Redness or lividity which is associated with the blood is subject to great variations:

(*a*) Simple erythema is apt to entirely disappear.

(*b*) Lividity, as in cyanosis, may disappear, increase, or remain, depending on the condition in the circulatory apparatus.

(*c*) Inflammatory redness, as in erysipelas, generally is largely lost; this is general in all lesions.

(*d*) Blood outside of the vessels remains unless it has some means of escaping (as by a cut).

(*e*) Colors due to exudates or transudates, or these when changed, are apt to remain, but become veiled by the loss of transparency through drying of the cuticle. Watery sudamina by drying may become of higher color or more opaque, or entirely disappear. Blebs are very apt to become the seat of decomposition, when they may become large and blood tinged; this occurs at times with extreme rapidity. These may develop in burns or infections entirely after death at an astonishing rate, but usually in such cases are highly blood tinged.

(*f*) Spots show or fade according to their nature; if due to blocked circulation (rare) they may remain.

B. Surface:

(1) "Goose-flesh" frequently develops after death, owing to the slow death of the tissues. Generally, it is safe to judge that the condition producing it existed at or very near the time of death. Thus, a man drowning in cold water or a man dropped into cold water immediately after death would show it. Electricity is said to cause it, but this has been questioned.

(2) Papules and other elevations remain or fade, depending on whether they are the result of congestion, exudation, or new tissue. Little vascular areas generally fade unless there has been great increase of blood-pressure before death, as in violent asphyxia, when they may even develop a hemorrhagic condition that did not exist in life. Fluid-filled elevations are apt to dry down. Indurated spots and pustules or cysts show only such change as would be due to loss of the blood of determination or inflammation.

(3) Diffuse swellings generally signify exudation, transudation, or secondary process of inflammation, and may remain unchanged or be much reduced.

(4) Bruises change color by normal decomposition of the blood, by imbibition of blood-pigments, and by decomposition (putrefaction). They often appear clearer after death, the conditions governing the postmortem change being the state of the tissue, the extent and degree of the lesion, and the condition of decomposition.

C. Appendages: Hair may grow, though probably the stories are grossly exaggerated. It will project, however, as the skin dries away. Few and slight are the usual changes, even when decomposition has advanced. The shedding of the hair is, however, significant, and it may come out very freely in septic conditions. Nails change very little, but the tissues under the nails may show circulation changes of importance.

D. Desquamations: These are at times all that is left of a serious lesion; the redness having entirely gone. The location, extent, degree, and sort, as well as evidence of any disturbance, or its removal, all are of the greatest importance. Thus, pearly scales with odor, or pearly flakes without odor, mean entirely different sorts of infection. Eczemas, lichens, and the other skin diseases all require the estimates to be increased by some degree because of departed evidence of inflammation.

E. Scars, keloids, and indurated areas all remain.

F. New growths generally lose color and appear less inflamed.

G. Early stages of inflammation where successive crops of lesions are to be found may not present their characteristic appearance. This is perhaps one of the most difficult of the classes to properly judge at the postmortem, because the dusky or red color often tells the clinician much, and its loss is a real handicap, but the observation of the condition of the deeper glands often makes up for this.

THE HEAD

The head presents an extremely complex group problem, and it is often amusing to note the way in which "complete postmortems" are performed without beginning the solution of these problems.

The **exterior** presents a segment of *skin* that is peculiarly sensitive to internal chemical changes. It supports various types of hair, and varies in the ear, nose, eyelid and brow, lip, chin, and scalp, and each difference indicates physical peculiarity. The skin is moved by a most intricate set of muscles which give rise to expression and guard the eyes and air and food orifices. It contains a number of specialized glands and is extremely rich in vessels and special nerves.

The **orifices** lead to important organs and are lined with mucous membrane which resembles the skin in that after death the lesions are much less striking than in life, by reason of diminution of redness and swelling following postmortem changes in the distribution of the blood.

It is truly wonderful to hear some pathologists describe throat, nose, and mouth as normal when conditions exist that would keep a throat and nose expert busy for weeks or even months.

Mucous Membrane.—This shows its condition to the careful observer not so much by its color as by what it has done in the way of secretion, and the pseudo-observer carefully wipes this away before he considers it worth while to begin to look, or else he does what is even more absurd, dissects under running water, so that secretions, juices, and blood are washed away and the tissues macerated in a non-isotonic fluid. This mucous membrane is very often thickened by fluid contents which are withdrawn during the processes of preparing for histologic examination, so that the microscopic sections show only an end-product quite different from the fresh tissue, and the presumption that no serious changes have existed is gratuitous, unwarrantable, and misleading. Nowhere else is the examination of the fresh material more clearly necessary than in the mucous membrane.

Mucous membrane also contains secretory glands that have ducts, and these differ greatly in health in different areas, and their secretions differ in ill health. Not infrequently one finds these glands and ducts involved in a process which shows where an infection began that has invaded the body, for it must be remembered that diphtheria is only one of many serious infections beginning in the orifices. Back of these glands and their ducts lie lymphatics and their so-called glands. Several times has the swelling of these glands caught my attention as my fingers passed over the throat, and led me to look carefully at the deeper parts

of the orifices, where the real trouble lay. The mucous membrane may be examined, as in life, by viewing it through the natural orifices with the aid of illumination. This is usually all that is necessary, and the further investigation will be discussed under the Nose, Throat, and Mouth. It must be remembered that bloody fluids, as in hemorrhage and edema of the lungs, may stain the mucous membrane, and that foreign substances produce changes after death; this is very noticeable when the stomach contents are purged, and pure water will cause maceration.

Foreign bodies in the orifices or deep in the passages are far from rare, and should not be overlooked. These are commoner in children and those whose mental condition is affected.

The proper examination and interpretation is so largely one of common sense rather than of special training or technic that little more can be said than to point out the possibility of the occurrence.

Fluids not normally present are not uncommon, and are always to be carefully examined.

Blood in the outer ear generally comes from the outside, and in such cases one must be careful to determine where it came from. In examining an ear containing blood care should be exercised not to move the head so as to bring the external canal into a vertical position before making the observation, but one should stoop down and with a bit of dry gauze wrapped about a pair of fine forceps cleanse the canal by stages, going in about $\frac{1}{4}$ inch at each stage. Blood in the nose may come from simple nosebleed, from violence, from sores, from bone injury, or from the throat, lungs, or gullet. Frequently it is of no importance, but because it may be of great significance it must be carefully observed. Blood in the mouth may come from the same causes as in the nose, or from the nose or from around the teeth.

Froth in nose or mouth is often ignored, but it never should be. Coarse mucous froth is not common even in the recently dead and is rare in those long dead, and its significance is usually easily determined when found.

Fine froth is quite common, and, while the bubbles tend to break and disappear, it is surprising how long such froth will remain. Generally the foam one finds is recently formed by the escape of mixed gas and fluid from an edematous lung. Not infrequently one finds a little dried foam about the mouth or nostrils after death by edema of the lungs, and in the back of the mouth is found in such cases more or less of the settled fluid, while slight compression of the lungs directly or indirectly will cause either more foam or foam and fluid, or only fluid to appear. The color of this foam and fluid will vary much, and in pure edema will be almost colorless. In congestion and edema, or in vasomotor edema with free leaking, it will be more or less pink or red. In severe congestive types it may be red from fresh blood or brownish from decomposed blood, or even blackish, though any marked change from red should put one on his guard to see if some foreign substance or fluid has gotten into the lung.

THE EYES

The eyelids should be opened and examined as a routine practice in all postmortems, but at times it is necessary to go much further. Asymmetry either of lids, or pupils, or position of the eyeballs is of such importance that it should not be overlooked. The lids will be found closed generally, but this in part is due to the common practice of attendants who close the lids soon after death. If the lids have not been closed the exposed part of the eye shows the effect of drying more or less quickly.

The almost classic error of being misled by a glass eye is one that will happen to any one of large experience, but this is instantly corrected by the application of the finger.

In examining the eye the thumb and middle finger are used after the lids have been separated, preferably by the use of the two thumbs. This use of the thumb and middle finger gives the best way of judging of size, shape, and tension of any small object; a fact that appears to be frequently overlooked. The position, size, shape, and tension of the eyeball can be easily judged by sight and touch, and peculiarities are so apt to be significant that there is small excuse for overlooking them. The condition of the cornea seen in cases of congenital syphilis, where more or less dense opacities are of frequent occurrence, is often of no small help in understanding a case. Such opacities should not be confused with occupation scars due to wounding or inflammation following injuries by foreign substances.

In cases where violence or injury has entered as a factor into the case it may become necessary to carefully study the eye as a whole and in detail. The orbital fat has a fairly definite relation to wasting disease and its disappearance is a serious sign, but this must not be confused with the sinking of the eye by reason of drying out of the contained humors which begins soon after death. The internal examination or dissection of the eye can be made in two ways.

Generally, I prefer to reflect the scalp well forward, bringing the flap so far that the supra-orbital ridge is freed from the skin. The whole optic mass is then freed from the orbit, and the large flap is still further loosened until the outer edge of the orbit is free. In this way the greatest freedom of approach is had without disfigurement, as the whole of the brow, lids, and conjunctiva are entirely intact in the skin-flap. Careful dissection can then be made of the eye from the rear or optic nerve side. By dissecting with a view to reconstruction the optic mass can be replaced in the orbit after dissection without the slightest disfigurement.

If the optic nerve and back of the retina is to be retained for study it may be necessary to use a small pad of absorbent cotton. This may be wrapped in black cloth or paper. In shelling out the orbital mass the attachment is cut free from the bone about the rim with a small scalpel, except the inner third, or nasal side. The mass is then loosened largely by blunt dissectors until the stalk at the back is reached. This is cut

FIG. 104.—A FRACTURE OF THE RIGHT ORBIT EXTENDING UP AND TO THE LEFT IN THE FRONTAL BONE.

The skin-and-scalp-flap has been reflected far down and includes the external ear and cheek. The contents of the orbit, having been brought out as a mass, have been dissected. The eye is seen freed from the fat and the muscles are still attached. No damage has been done to the conjunctiva. Hemorrhage into the scalp is seen in the anterior flap and into the tissues above the ear. The external auditory canal is cut close to the skull and is seen as a dark oval. The parts are easily replaced, leaving no disfigurement. The line of scalp cut is seen in Fig. 105, *S–S′*.

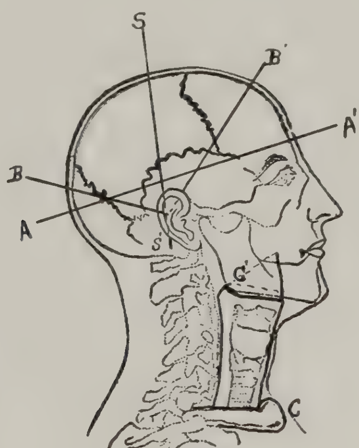

FIG. 105.—LINES OF CUTS ABOUT HEAD AND THROAT.

S–S′. Line along which scalp is cut. *A–A′*. Anatomic cut of skull. *B–B′*. Usual cut of skull. *C*. Curved cut around end of clavicle extended outward close to the bone for removal of throat organs. From *C* to *C″* are seen the lines for cutting away the skin from throat mass and the throat mass from the spine. At *C″* the lines along which the knife passes to separate the top of the throat mass from the jaw at the sides, the pharynx at the back, and where the tongue is cut across in front.

off by using a small scalpel. The more usual but less satisfactory method is by chiseling away the floor of the anterior fossa of the skull. For this work the chisels sold in the shops are much too large for nice dissection. I use one made of tool steel (see Fig. 39), chipping with a light blow of a small metal hammer, and removing the fragments with stout forceps. The use of the saw is entirely out of place except where reconstruction is not to be attempted. My first dissection of the orbit was made with the saw, cutting away a large wedge-shaped piece of the frontal bone, making an opening 3 inches across above, and with the sides of the cut sloping inward and ending at the roof of the orbit.

Fig. 106.—The Right Orbit Emptied from the Front.

The skin-flap is reflected along a line from the top of the nose to a point below the ear. The orbital fat has been opened and the eye, with its muscles and the optic nerve attached, is seen to the right and below. Severe injury had been done to the brow and it was necessary to explore the whole orbit without in any way using such force as would damage the delicate bones of the region. Note the hemorrhage above the orbit. (Compare with Figs. 137–139; same case.)

The saw did not enter the orbit at any point. The opening of the orbit was made with a chisel. This method is a very satisfactory one where there is no objection to disfigurement.

It is possible to reconstruct after such a cut has been made, but it is tedious, and can hardly be successfully done without using plaster of Paris to hold the segment of the frontal bone in place.

The results of reconstruction attained by some of the advocates of this method do not appeal to me. The lacrimal apparatus can be fairly well examined by carrying the flap in the first method down the nose. This is rather a delicate piece of work, and if much care is not exercised the disfigurement is considerable, because the skin will stretch over the

nose and not follow its contour, and the inner canthus will be brought forward in a most undesirable way. It is hardly necessary to caution those not skilful with the knife to avoid any and all attempts at enucleation or orbital dissection except that from above, where the results of clumsy work show least. For studies of the optic nerve it is better to dissect from above, but extreme care is needed in freeing the nerve where it passes through the bone, as these bones are generally brittle and sharp when broken. Where the bone is found to be unusually

FIG. 107.—THE BASE OF THE SKULL AFTER THE BRAIN HAS BEEN REMOVED.

The dura is still in place. Note the general and special architecture and the distribution of the supporting structures; also the central position of the pituitary body; the relation of the carotids to the optic nerve and the cranial nerve-roots. (Compare with Fig. 108.)

brittle it is better to cut the optic nerve on the inner side of the foramen and free it from the canal, removing it in two sections, one with the chiasm the other with the retina.

Eye Conditions.—After death the eyes dry out rapidly, specially if the lids are not closed, and the cornea becomes opaque and cupped. After decomposition sets in the eyes usually protrude more or less and may swell and burst. Flies choose the orifices to deposit their eggs in, and one frequently sees a bunch of cream-colored little eggs in the

angles. The hatching out of the larvæ or maggots in these places hastens decomposition changes.

Abnormalities of the parts will be noted and their significance in the case will be considered when they are observed.

Injuries about the orbit are very apt to give rise to "black eye" because the blood finds easy paths to traverse and "points" in distant places. Their study becomes more difficult on this account. My favorite

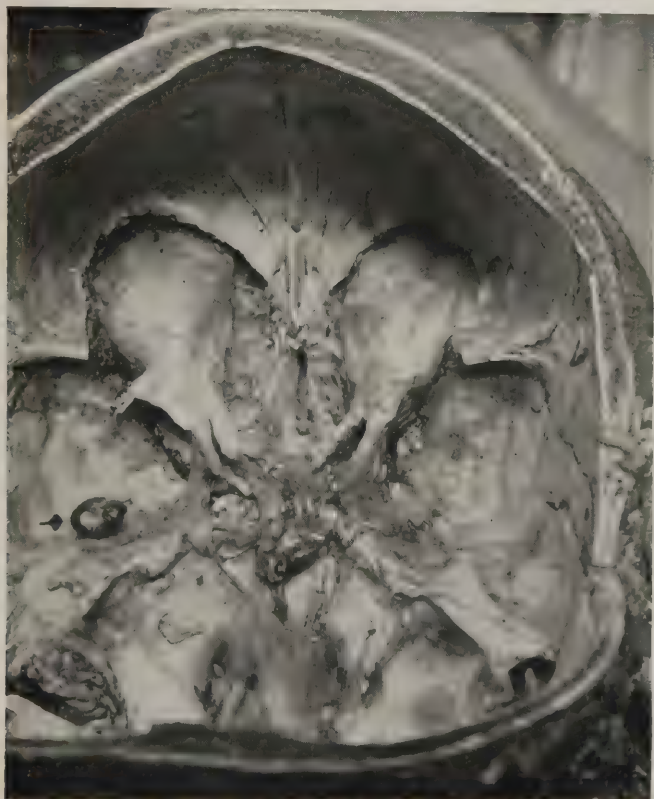

Fig. 108.—Base of Skull Dissected.

The dura has been removed from the anterior and middle fossæ. The roof of each orbit has been chipped away. The insertion of the orbital mass is displayed and the optic nerve as well as the supra-orbital nerve are clearly seen. The bends of the carotid arteries in the region of the sella turcica. The pituitary is seen to the left, having been removed. The Gasserian ganglia are seen slightly disturbed.

method of examining the orbit was devised to lessen these difficulties, and its use is most valuable in such conditions. Swelling of the lids due to extravasation will remain for some time, while congestion and at times edema may be considerably reduced after death; indeed, may disappear so completely as to be misleading.

Diseases in or about the orbit demand the art of the ophthalmologist to properly value and explain what is found, but no one can afford to

ignore conditions, and, even though the elaborate jargon of the specialties is an abomination, we can observe what exists and conclude as to its significance. This we should always do, even though for the moment such words as "hypopyon," "chalazion," or "pterygium" are not present to distract our minds. The relations of the parts and the paths by which infection can reach vital organs, either by simple extension or as the result of injury, are matters of vastly more importance than names that smack of pompous pedantry.

"Arcus senilis" is a term that has been rather too freely used to cover all sorts of arcs and rings found on or about the cornea; it should be restricted to the crescent that may extend to a circle and is found in many old persons. In itself it is insignificant, but as an index of changes in the fibrous elements in important organs, such as the blood-vessels, it has a decidedly large importance, because it helps us to discriminate between different types of vascular changes. There are other ring opacities, often seen in negroes, that have a similar value. I have often seen such rings in young pigmented white persons with lateral curvature of the nails and chronic enteritis.

Asymmetry of the eyes is always a matter that attracts our attention. While it often has no definite value for us, it may furnish the most needed clue. Criminals and defectives show this asymmetry very frequently and in many ways. Those with brain lesions and diseases, aside from pathologic criminals, often show it. One must always be cautious not to mistake the result of old squint or lesion for a sign of some active condition or stigma of degeneration. The size of the pupil gives us but little help except when it has been excessively dilated or where asymmetry is found.

In opium-poisoning there is a final dilation, so that the pupils do not retain the extreme contraction in ordinary cases.

Congestion of the cornea is often found when the body has been much compressed and is found when postmortem blood-pressure has been raised. It is often seen in mania and in chemical burns.

When the blood-pressure has been raised the lines of the vessels are clear, while after inflammation there is apt to be more of a blush.

Hemorrhages occur in cases of violence, infection, and in asphyxia with increased blood-pressure, and at times without assignable cause. Their size, shape, and condition should be interpreted.

THE EAR

The external ear is often malformed and becomes a valuable sign and is a common stigma of degeneration. Injuries to it are apt to be associated with violence to the brain.

Inflammations may be limited to any part or may extend widely. The significance of discharges from the ear is generally appreciated, at least partially. One occasionally sees the mistake made of calling the discharge from a chronic otitis cerebrospinal fluid, and one frequently finds clinicians making serious errors in the matter of the rela-

tion of otitis and brain symptoms. The examination of the external canal is much the same at the postmortem as in life; first securing good light, grasping the ear firmly between finger and thumb, pull up and back with such variation as is necessary in each case; usually a good picture of the drum can be obtained. When further investigation is necessary one may dissect the scalp-flap (made in opening the skull) well forward, severing the external canal close to the bone. This gives a considerably clearer view of the whole canal. A small crescentic flap may be made where the head is not to be opened and a small trephine used to open the bony canal.

The interpretation of findings should never be undertaken unless a good conception of the peculiarities of the particular case has been gained. The bony framework varies in substance, as well as in form, so much that it is necessary to know how much resistance had to be overcome before the condition could have been produced.

Ruptured drum-head may be caused by the most trifling force, or may indicate great violence. Generally it is not necessary to dissect further, but where serious questions arise the plan must be adapted to the conditions.

Bone carving is necessary in a limited number of cases to determine the condition of the middle and inner ear and the mastoid cells, and this is generally best done with a moderately large chisel and a massive-blow hammer (wood or hide), the blows being directed so as to remove a large wedge whose apex will be downward, and which will include the greater part of the petrous portion of the temporal bone. The use of the saw in removing such a wedge is seldom desirable, owing to the confined space in which one has to work and the greater usefulness of the chisel.

If a fracture of the bone is to be investigated the saw is as apt to cause as much disturbance of the fragments as a well-directed chisel cut well removed from the fracture.

After the wedge has been elevated and the attachments of the soft tissues severed, it is removed, and it is then frequently necessary to saw across it in such a way as to open the desired parts to view. It is not easy to follow a description of such work, and I believe it will be found best to orient the wedge with relation to the skull and compare with Fig. 109; then the desired cut can be readily located. One will not be likely to acquire skill in this work without careful practice, but by following the landmarks, specially the openings of the external canal and the eustachian canal, one can open the apparatus at any point or in any plane. It should be remembered that the arrest of discharges from an ear that has long been running is a very common occurrence when the inflammation has gone inward to the brain, and many cases of very slight injury have been reported where the history of old ear disease is not given, but which can be elicited with care, and it is important in all cases of meningitis when violence is suggested to look at the ears carefully. Injuries to the ear with inflammation are not always taken care of by general surgeons, and I recall one very important case where, after a

fracture of the temporal bone with rupture of the drum, the case was discharged as "cured" without examining the ear, to die of meningitis some weeks afterward.

The architecture of the bony support of the ear varies very greatly, and may be directly responsible for the way infection spreads, as well as for the peculiarities of the injury resulting from violence.

This can be determined generally by observing the chisel cuts or the sections in sawing, but I have not rarely found that the clearest con-

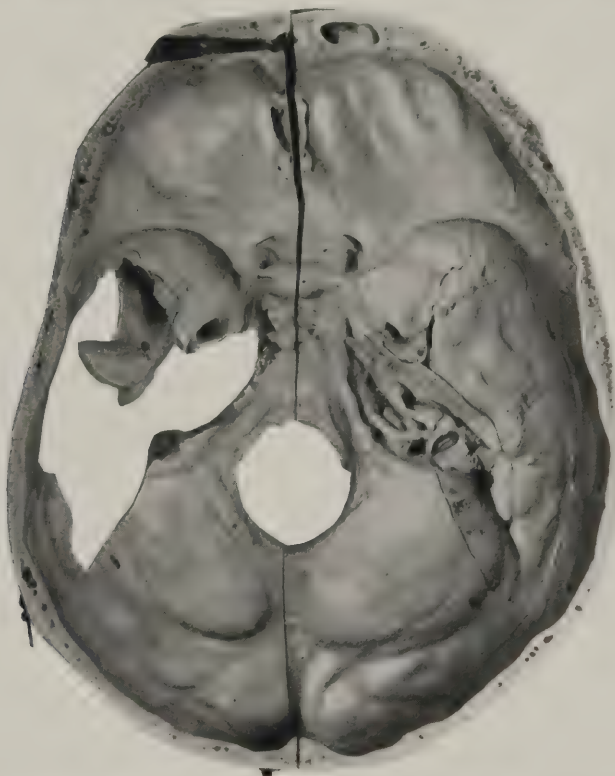

Fig. 109.—Floor of Skull Dissected. (From a French dissection reproduced by courtesy of the Wistar Institute of Anatomy.)

On the left side the temporal bone has been removed and the relation of the lower jaw is well displayed. On the right side the inner ear has been displayed by skilful carving. Note also the architecture of this particular skull, specially the asymmetry.

ception was gained by cracking the mass open as one would a nut by one well-directed blow of a metal hammer, the mass being held by the sequestrum forceps and resting on some hard object, as a brick.

If there is no objection to destroying the contour of the head, as is ordinarily the case in the dissecting room, one can cut out a wedge of bone by sawing downward from the main circular cut by which the brain was removed, this wedge having its narrow end about 1 inch wide, and including the exit of the auditory nerve near its posterior part; its base

should be about 3 inches wide. This wedge is, after removal, placed in a vice with padded jaws and sawn in the selected manner. At times one will be discouraged by finding the bones so hard and brittle that dissection is almost an impossible task. I have seen it quite as brittle as glass and entirely shattered by the chisel. In such cases the only instrument to use is a fine dental saw.

THE NOSE

The nose receives too little attention in the literature on postmortems as well as at most actual examinations.

This was vividly impressed on my mind at a postmortem I made on a man who died in an insane asylum. The clinical diagnosis was dementia præcox, and the assembled clinicians and pathologists began to depart as soon as a little chronic meningitis was demonstrated about the center of the floor of the brain case, and no evidence of hemorrhage, tumor, or violence was found.

The distribution of this was too peculiar to be passed over, and I opened the case of the pituitary body to find still more marked changes, and going further I opened the sphenoid sinuses, to find them completely filled with an old, infected, semifluid mass. Going deeper still, I found a chronic inflammation of the upper part of the nasal chambers. The man had died of an extension from a nasal catarrh to the base of the brain through the sphenoid sinuses, and had been allowed to suffer for months without proper attempts at treatment, and at the postmortem only one out of seven present evinced the slightest interest in this unusual but extremely instructive case. Fortunately, throat and nose specialists are doing excellent work on the sinuses, but general surgeons and postmortem operators are apt to overlook their significance.

The **sinuses** are usually studied in connection with the nose in clinical practice, and may be conveniently grouped as part of the nasal system at the postmortem, though their dissection becomes more or less special. The frontal sinuses are best approached after the brain has been removed by using a small chisel, not over $\frac{1}{4}$ inch wide, and a metal hammer, chipping away the inner table of the skull near the midline in front and above the brows. They may be opened with a trephine from the front after reflecting the scalp well down to the upper edge of the orbit.

The circular cut made to remove the skull-cap when repair is not necessary generally opens these sinuses, specially if the cut is carried well down toward the brows (see Fig. 109).

I have rarely seen frontal sinusitis give rise to meningitis, owing to the density of the inner table and the usual circulation supplying these cavities.

The sphenoid sinuses lie where the anatomies often picture a solid mass of bone, below and slightly in front of the sella turcica, and my experience teaches me that they have an importance not yet appreciated in pituitary and brain conditions. They are to be opened from above by careful chiseling and forceps work.

The maxillary sinuses are best reached by reflecting the frontal scalp-flap well down and trephining or chiseling off the outer wall of bone, but I have often found it desirable to go down from above through the floor of the skull, though this requires some care and skill, and if the bones are brittle is quite difficult, and requires rather extensive chipping away of the floor of the anterior fossa and constant trimming and cleaning of the field of work, so that the débris will not cloud the view and cause one to go too deeply or damage the dissection. I have never seen fatal results follow involvement of these sinuses except where a general septic condition existed.

The **external nose** is often a guide of value in judging of the character of the individual and of the general developmental and nutritional conditions. The size, shape, and rigidity all signify definite internal conditions. Abnormalities such as are found in congenital syphilis are generally recognized, and have been for many years, but the other variations are commoner and more useful.

What comes from the nose is always to be examined and the general condition of the cavity is to be determined. The interior of the nose can be examined as in life, either by pressing up and back on the tip and reflecting light into the deeper portions, or by dilating. I find the sequestrum forceps useful in dilating the nostrils to gain a clearer view in routine examinations. The dissection of the nose can be made best from above, where disfigurement is not desirable, by chipping off the roof through the floor of the anterior fossa of the skull.

Where the mouth can be widely opened one can cut away the hard palate with a small chisel. Where a full view of the nose is demanded parts of the sphenoid bone must be cut away and the orbits removed, their contents being reflected forward and the inner walls removed in small fragments. At times I find it expedient to use a thin pair of hemostats with small cups in the blades to pass into the deeper parts of the nose. These are then opened and turned and closed so as to bring away the coating, if any, of the mucous membrane, while closed they act as a probe, and after being opened as blunt curets. False membranes, mucus, and even the mucous membrane can be secured for examination. Some help is occasionally had by grasping the uvula and cutting away the sides of the soft palate, thus gaining a larger view of the posterior nares.

THE MOUTH

The mouth as a cavity appears quite simple, but as an organ-complex it is far from simple. As a whole, it varies very greatly as to size and shape, and the proportions and relations of its parts and each variation means something if we are skilful enough to be able to read the picture properly.

Developmentally, it is one of the very best indices we have of the life history of the individual, not alone physically, but mentally as well. The habit of ignoring or scorning this is a mark of the hasty, impatient,

uncouth mind that wants to be great and wise in impossible ways and fails to use the means provided.

Dental science and art are rapidly pressing on into this hitherto neglected field along a few lines, and dental surgery and orthodontia are making very marked progress, but even the most advanced students of dentistry have hardly begun to grasp the significance of the mouth as a part of the whole organism, or as an organ made up of many interrelated parts.

A few specialists have carefully studied the mouth as the organ of speech; others, as a part of the digestive apparatus; and still others, as part of the respiratory mechanism.

Fig. 110.—Compare with Fig. 69. This photograph was overexposed in order to show the interior of the mouth which has been opened. Note the retraction of the gums, the irregularity of the teeth, the gastric hair, the common position of the tongue in death, it being clearly bunched, ridged, and stiffened. The early stiffening of the tongue might serve as a sign of death before general rigor has set in. The antemortem flaccidity is in marked contrast to the postmortem fixation.

The **lips,** being the most generally used organs of expression, still retain considerable character after death. They are subject to injuries and diseases which, when found, are always important. They change color during life in a way that gives the diagnostician much assistance, and the residue of color found in death is always to be considered.

The **teeth** may help us or mislead us at times. They seldom show recent changes, but give us much help in regard to chronic or old changes, such as produce chemical or other vital disturbances. Their size, shape, texture, preservation, position, all mean something in every case. Congenital defect or disease is so commonly indicated by the

teeth that one cannot afford to ignore them even in the most perfunctory routine examination. The habits of life, whether of eating, smoking,

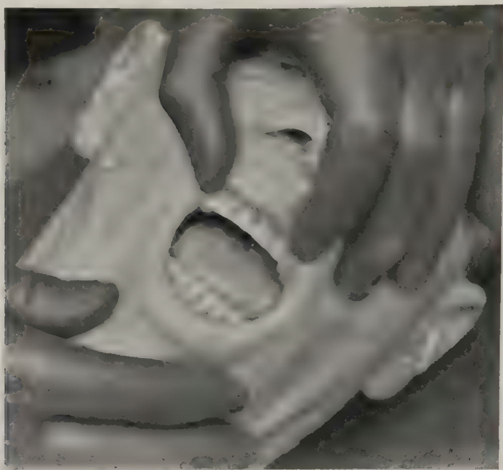

Fig. 111.—A block was placed under the head. The jaw was depressed. The head was thus bent forward on the neck so as to bring the roof of the mouth down on the tongue, which is seen projecting slightly beyond the teeth.

Fig. 112.—The block was removed, the forehead pressed backward, the jaw held up and forward, without disturbing the articulation. The fingers hold the lower lip downward. The roof of the mouth is entirely separated from the tongue, which is well behind the teeth. In this case rigor had fixed the tongue and finer throat muscles. The tongue is seen to be slightly bunched (less than in Figs. 109 and 114). Rigor was beginning to fix the facial and skeletal muscles. These are particularly interesting when compared with certain medicolegal testimony. Had the final rigor come on in either of these positions, or the body been embalmed, we could have two entirely different pictures.

or cleanliness, and often the occupation, show in the teeth. Their condition influences digestion and they respond to nutritional disorders. They are significant of age, and are often of immense value in the matter

of identity. They are subject to various injuries and in medicolegal questions often play a large rôle.

FIG. 113.—The upper part of the head is raised on a high block, bending the neck and raising the throat column up toward the roof of the mouth, throwing the tongue forward between the teeth. The top of the tongue was in contact with the roof of the mouth.

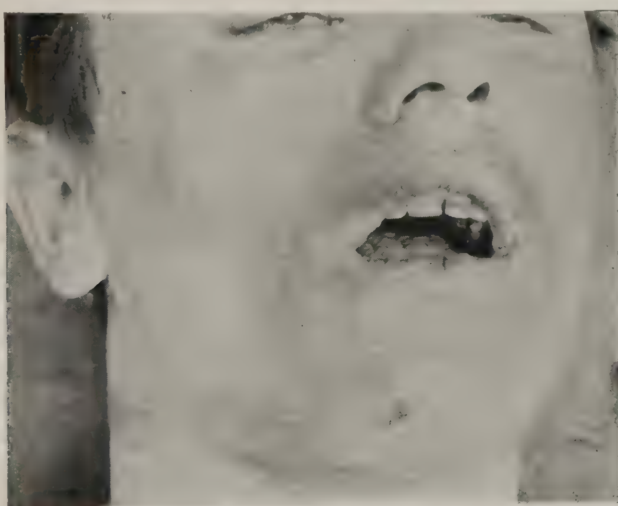

FIG. 114.—The shoulders are raised on a block and the head falls easily and freely backward, carrying the roof of the mouth away from the tongue, and the jaw rises, leaving the tongue on top of the throat column back of the teeth and apparently retracted and lowered. The tongue does not touch the palate. Rigor had fixed the tongue and the intrinsic muscles of the throat column, but had not reached the large skeletal muscles of the neck. The bunching, with wrinkles, of the tongue is a common condition. These extremes and all intermediate positions were readily produced by simply bending the head on the neck.

The **gums** share with the rest of the mouth in general infection, and they are the seat of many local sores that may give the clue to general

conditions. The deposit of certain metals in the gums, forming what is called the "blue line," is often the only indication one finds of a general intoxication. Lead is frequently found to be a cause of this line and argyria is said to begin here to show, in such a line.

The **tongue** varies greatly in size and shape and somewhat in position. It is usually found bunched after death, as if there had been some positive contraction of its muscles. Its position in relation to the other mouth parts has been grossly misconceived by many writers. Riding as it does on top of the neck or throat mass, its position in the mouth is very largely dependent on the flexion or extension of the head on the neck. Figs. 111–114 show how this can be entirely raised at will after death, and show how utterly wrong are the too frequently made assertions regarding the significance of the position of the tongue after death. After cadaveric rigor has passed off, and the tongue muscles have relaxed or softened, it will fall into the back of the throat if the body is on its back, just as it does in life during paralysis or in relaxation during sleep.

The coat of the tongue has a large significance in all functional disturbances of digestion. The white coat of hyperacidity and the red tongue of hypoacidity are common enough, but we see these too frequently passed by at the postmortem.

Injuries to and diseases of the tongue are sufficiently common and significant to justify at least a glance at every postmortem. Certain diseases are specially prone to give tongue signs. Brain conditions frequently show changes in size, shape, or position of the tongue; syphilis often attacks the tongue. Occupations and habits, such as glass-blowing, wind-instrument playing, smoking, produce changes. Many poisons cause changes of varying degree and of different sorts, from the burns of corrosive substances to the simple color changes of mechanical stains.

The **glands** about the mouth may be examined as in life by viewing and palpation, and the findings have much the same values.

The parotids can be reached, if the skull is to be opened, by reflecting the anterior flap far forward and severing the external auditory canal close to the bone. The tonsils can usually be studied by forcing open the mouth and, if necessary, removing them, as in life. Those glands about the floor of the mouth are best reached from below.

In order to examine the mouth it is often necessary to forcibly overcome the rigor of the powerful jaw muscles, and this is not always easy. I find that the sequestrum forceps (see Fig. 45) is the most convenient instrument. The smooth, rounded, oval, wedge shape of their jaws when closed gives them great value. The point being introduced between the molar teeth, well back, is gradually pushed inward, and after the teeth have been separated slightly on either side, by using the closed instrument as a wedge, the jaws can be opened forcibly but carefully by opening the forceps. If the fingers are used, one should be very careful to avoid wounding them. At times one can overcome moderate rigor by bending the head back over a block, and holding the forehead with one hand while the base of the thumb of the other hand is pressed

down on the tip of the jaw. If the rigor is very firm this process will often succeed after the first start has been made with the forceps as described. Few mouth-gags are satisfactory and powerful separators are very likely to break the teeth. Force should never be exerted on the front teeth, as serious disfigurement is apt to result.

It is possible to examine the mouth through the floor of the cranium by continuing the removal of the structures of the nose and the palate; in fact, this is the only way one can study the relative positions of the parts connected with the floor without first disturbing them. I find it desirable to work from the center outward, taking away small pieces at a time, and using care not to cause fracture of the superior maxilla while removing the hard palate. The wings of the sphenoid, of course, must be removed and part of the floor of the middle fossa. In the dissecting room a horizontal section may be sawn at the level of the tip of the nose, so as to escape the tooth roots, and this may be varied by slanting it downward at the back so as to directly open the upper pharynx. The method of sawing the skull in a plane through the midline, front and back, is occasionally of value where displacement of the parts is no detriment, and where a large space is required to work in, but it is difficult to make the body presentable after such a proceeding, owing to the disturbance of the nose.

Where there is no objection to the difigurement of the neck, and the front cut is carried up to the lower jaw, the removal of the floor of the mouth with the throat mass is quite simple. This allows the floor of the mouth to be studied with its natural associates in the throat, and the sides and roof of the mouth can be studied from below. This method does not permit of a determination of the position of the parts as well as either the upper or the posterior methods of approach, but is satisfactory for ordinary cases when allowed. I am accustomed to modify this method so as to save the upper neck by separating the skin from the throat mass and strongly retracting it upward, then removing the mass. The method of approaching from the back will seldom be employed except in the dissecting room. It implies the removal of the upper spine through a cut in the back of the neck, and requires so much skill to avoid forceful bending and disturbances that it is a method only for the skilled worker who already understands how to do it.

THE SCALP

The scalp is so anatomically simple and so pathologically unimportant that one is tempted to pass it by without giving it its proper consideration.

The scalp varies greatly in thickness and still more in texture, so that injuries produce very varied effects aside from the variation to be expected from the sort of violence. A blow that will cause a laceration on one head will not produce a mark on another, but the transmitted violence carried by the different tissues to the brain may show much less variation. A fat scalp makes a better protecting cushion than a fibrous

one, though it is more easily wounded, and one devoid of hair is apt to have less fat, and, therefore, be a doubly weak protection because of the loss of both hair and fat. The resistance to infection also varies greatly. While pus-forming organisms grow freely in one and pass readily along the pathways into the skull, in another infection seems to be resisted with remarkable power, and extension is restrained both by peculiarities of texture and by vital activities. It is not uncommon to find the value of the hair as a mechanical protector greatly overestimated. This is easily proved by tapping the head and the forehead, and noting how little effect the hair has in deadening the jar.

On the contrary, the protection offered by the hair against radiant energy, specially from the sun's rays, is scarcely ever fully appreciated. This protecting power suggests a very obvious need for protection that has hardly begun to be understood, specially in relation to the effect of high-power artificial illumination. The devitalizing or depolarizing power of electric emanations on tissue is becoming better known. More particularly are we brought to a realization of the effect of the *x*-ray, but it is only a short step along the same line that will soon be taken when we will realize that electric emanations are specially effective on the highly specialized brain tissues, and that the relation of solar rays and other radiant force are so intimate that we will need to study carefully the significance of the hair and scalp, as well as the cranium, as a shield against radiant energy.

I find so many serious injuries to the brain where only slight marks are discovered on the outside, which I am compelled to account for, that I am in the habit of estimating the elasticity and cushioning effect of the scalp as a thing apart from the tensile strength that resists direct wounding.

The examination of the scalp is not a simple matter, and it requires skill, both of the hand and of the eye, to properly carry it out. The underlying skull is apt to have irregularities that may entirely mislead the examiner. If the head has rested on some hard object for some time the point of contact will be compressed, even if there is a bruise at that very point. Very frequently swelling is found at a point far removed from the point of injury. This is generally true where fracture by transmission of violence has occurred. Blood may travel, specially in old persons, for a long distance in the tissues of the scalp, to appear or "point" at a distance from the seat of bleeding, which may itself be the result of transmitted violence and not the seat of the original injury. It is necessary to employ many small arts in studying the scalp.

If the hair is short or very thin or the head is bald the difficulties are much reduced. If the hair is stiff and not too long I pass the ulnar edge of the left hand over the scalp, moving it against the lay of the hair; as the hairs are released they spring back, and in this way I gain a good view of the scalp and at the same time can feel the contour with the left hand. The right hand is free to assist both in procuring a clear view and in feeling the scalp. If the hair is long a mass is grasped by one hand; from this a small tuft is detached by the fingers of the other hand; by

pulling in different directions the scalp is brought into view in a spot; and by proceeding systematically over the head the whole is easily and quickly covered. While these small tufts are between the fingers a slight pull or tug will show variations in the scalp that would otherwise escape notice, and if injury has been done it will be detected by the loosening of the hair or the change in tension of the scalp, and such injuries or conditions as cause bruises and swellings are quickly demonstrated.

These methods are specially valuable in life or where one hesitates to cut the scalp, but are of great assistance where it is desirable to estimate the violence, because cutting and reflecting the flaps often requires force enough to materially change the evidence.

At times a small cut or puncture over a suspicious area will be of value.

The free dissection of the scalp is necessary in many cases. Generally this is done by flaps, but one must frequently dissect with regard to the lesion.

THE SKULL

The skull has, so far as I am able to learn, never been adequately discussed. Its anatomic peculiarities, of course, have been freely described, but I suspect that a ship designer who used similar methods in describing and designing a vessel would fail utterly in his work. So I find those who apply purely anatomic methods to the study of the skull fail utterly in the elucidation of head injuries. The skull has a general plan of construction which may be called its architecture, and its details, both of construction and material, vary so considerably that it is entirely impossible to lay down rules that apply to the problems in any but a very general way.

This variation is surprising to many, and may be demonstrated by a trip to any large hatter's, where hats are fitted by means of taking off an outline of the head.

The variations found in the contour are but a sample of those found throughout the whole structure. What is perhaps harder to grasp is that each variation means something both in cause and effect. While we find few who read these signs intelligently and many who ignore them through superficiality, and while these signs are at times beyond our interpretation, how can an operator face the problems of injury to the head decently or successfully if he does not understand these things? In medicolegal cases where violence has been done I am frequently required to solve problems whose solution would be entirely impossible if I had not a grasp of this variable architecture of the skull. As similar cases are being treated in hospitals, I conceive it not out of place to insist on the general usefulness of such a study of the skull, both for the surgeon and the ordinary postmortem maker.

Size.—Apart from questions of brain capacity, hydrocephalus, or idiocy, the size holds little of vital importance beyond one question, What is the relation between the size of the skull and the size of the body?

Shape.—In general, the shape depends on the adjustment of the parts and has great significance to the psychologist. It has much value in relation to inheritance, nutrition, and type. In our work it is of direct value in all cases where its peculiarities have influenced the infliction of injury or changed the effect of violence or of disease.

The shape cannot for us be dissociated from the structure because the total effect is always dependent on the relation of these two. The contours may vary without effect if the thickness and quality of the substance so vary as to balance the effect. Generally the interior and

Fig. 115.—Several purely anatomic pictures of the skull are here introduced for handy reference and because they give the relations and landmarks, as well as show the architecture so often mentioned. This figure shows the usual anatomic cut of the skull made for removing the brain. (Compare with Figs. 116 and 117.) (By courtesy of Wistar Institute of Anatomy.)

exterior contours agree, but often one finds thin or thick areas, so that the two contours do not agree. The interior contour has to do with housing certain organs and the subsidiary and sustaining organs and tissues. This interior contour really goes with the study of the contained organs. The exterior contours are modified by the other function, that of protection. The whole series of countors is laid down on certain general lines made necessary by the chief function of all architectural construction—support. It is supported below; therefore we find an arch resting on the supports and an inverted arch forming

part of these supports; the inner surface of this arch forms the basis to support the contained organs. The two arches are of slightly different curves. The violence to be met in front and behind and above requires entirely different arches with subsidiary supports.

The distribution of material differs even more than the curves of the arches, and they both vary greatly in different persons. The relatively flat sides have special accessory deposits of bone, and advantage is

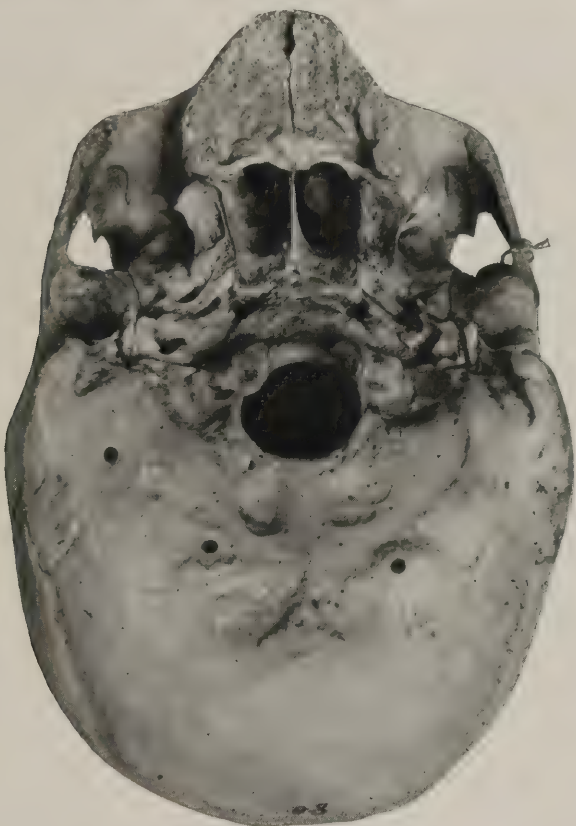

FIG. 116.—Under surface of skull taken at slight angle so as to bring out nasal cavities and the areas through which one must cut in making the approach from above; also note the different types of architecture in the different areas. Compare the glenoid fossæ with Figs. 109 and 115 in order to see how the force of a blow on the tip of the jaw is carried to the great vessels of the brain. Consider how differently such structures will vary in their transmission of violent force. (By courtesy of Wistar Institute of Anatomy.)

taken of masses of muscle or adjacent bone to reduce the material. The resulting construction is so utterly different from a sphere that it seems childish to continue to talk of contre-coup as if it occurred as in a ball or globe. The structure that receives a blow either absorbs the force as does a piece of putty or fat, or it breaks, using up the force in breaking, or it passes the force along as a chisel does when hit by a hammer, or it acts as a spring. The skull does all of these in varying extent when-

ever it receives serious violence, but what it does with such force depends on the nature and condition of the bony substance, as well as the distribution of the various bone elements and also on the architecture.

Now the bone varies in tensile strength and in elasticity in several ways. No one has finished his study of a fracture of the skull or of violence to the brain until he has investigated these matters.

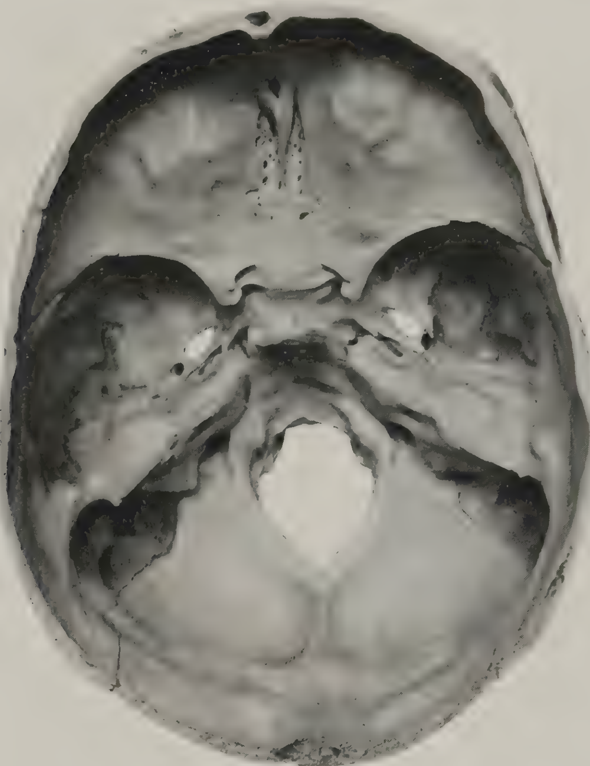

Fig. 117.—The Floor of the Brain Case.

Note the arrangement of subsidiary internal arches and supports, as well as the asymmetry. Compare with Fig. 118, which shows the fresh bone. The lines of junction of the various bones is unusually well shown. Consider how the violence of a blow received at any point would be transmitted through these structures so as to meet that traveling over the vault. It will be readily seen that the focus will be displaced toward the base from the diametrically opposite point. (By courtesy of Wistar Institute of Anatomy.)

Force brought to bear on any point of the skull will be, at least in part, transmitted, and will travel from the point of impact in all directions, but not with equal speed or with equal results, for if one taps the occiput well up and to one side with a hammer the force will be found transmitted not to the opposite point of the skull, but to a point nearer the base, because of the power of the base to retard transmission of force. At this point, which I call the "focus," violence is apt to be done either to the bone or to the contained organs. A blow on the occiput often ruptures the floor of the anterior fossa, even though no fracture is made in

the occiput, and the bruise of the brain in the frontal lobe may be much more severe than that under the point of contact.

It is necessary to study the contour at the point of impact, and equally necessary to examine into the thickness, brittleness, resiliency, tensile strength, and transmitting quality of the bone in that place; then the focus is found by carefully tapping this spot and then examining the lesion produced. In no other way can we understand what has occurred.

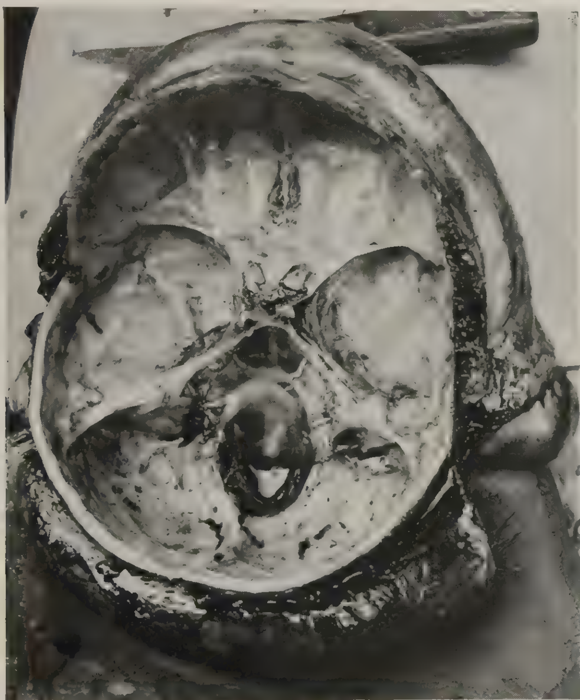

FIG. 118.—THE INSIDE OF A FRESH CASE WHERE VIOLENCE WAS DONE TO THE BRAIN BY TRANSMITTED FORCE. (Compare with Fig. 117.)

Note the different optical properties of the fresh bone; the different type of architecture as a whole and in details. The camera was a little to the right side, but the asymmetry is still quite clearly shown. Note also the right Gasserian ganglion.

The listing of the size, shape, and position of the lesion is what is generally advised, but without the essential data it is only a waste of time, because the size of the fracture, even when taken in connection with its location, does not give us grounds to judge of the sort of force or of its amount. I have seen a 6-inch fracture from a light fall and death only by reason of infection, while a fracture of 1 inch at the focus was found in a case of instantly fatal violence. In the one case the bone took up all the force and broke, while in the other, it being very resilient and hard, it transmitted nearly all the force to the brain.

Diseases of the skull are generally easily recognized, but many conditions that are really extreme physiologic and anatomic variations

may either result from general diseases, congenital or acquired, or may give rise to conditions which constitute the disease. The skull must be explored at times by chiseling or sawing out areas, or by removing adjacent parts, and in serious cases it is desirable to determine the force necessary to fracture the bone of a part. The relation of bone condition to general diseases should always be borne in mind.

The examination of the skull begins with the inspection of the head, is continued during the minute inspection and palpation, and becomes intensive as we remove the scalp. The nutritive tissues and the circulation are noted in general, and may require careful study.

In opening a skull where a fracture should be suspected all use of chisel, hammer, or hooks should be avoided, and only the saw used in the early part of the work. After the conditions have been observed it is often desirable to use the hammer to determine the quality of the bone and to test transmission of forces, and at times one has to chisel away the floor of the fossæ to follow out the sequelæ or to dissect some other organ. The use of the chisel and hammer to complete the primary cut is generally inexcusable, even where the operator cannot use the saw properly, except in those rare cases where the saw cut is carried so low as to enter the petrous portion of the temporal bone.

It is frequently well to examine the skull and its areas by transmitted light.

The Brain

The brain being the most complex mechanism in the world, it is but natural that its study should be filled with difficulties, and when we consider the way it is compressed and the extreme delicacy of the units the marvel is that we have so much available knowledge. The rapid progress made in the last half century has hardly made it possible to stop and sum up the whole subject in such a way as to formulate the one best way of dissection. In fact, I question whether there ever will be one best way found because of the vast multiplicity of problems that present themselves in regard to this organ.

No one can have a fair conception of modern brain anatomy, physiology, and pathology without having a feeling of wonder at the marvelous perfection of intricate adjustments of myriads of terminals and connections, but the postmortem room is such a practical place that there is no time for emotions, and one must come to the dissection of the brain with a definite purpose or plan; yet it is evident that no suitable plan of action can be devised or prescribed unless we stop long enough to realize what sort of organ we are to examine.

Unfortunately, the need of specialization has forced brain experts to become narrow, until it is impossible to find a brief adequate presentation of just what the brain is on which to base our consideration of its dissection.

I find the thought suggested by the telephone systems of great cities very helpful, specially those parts which have to do with the great cables composed of transmitting wires that lead to relay apparatus,

switch-boards, and local distribution centers, and the ultimate distribution into the homes and business places where ideas start and stop. Instead of being spread over a whole city, these are huddled together in the brain into a mass suggesting a cauliflower and about the same size, and, instead of having a few thousand units, it is made of millions, and it is self-adjusting, self-regulating, and self-repairing.

It is no wonder we find difficulty in finding a plan that will be universally applicable for taking this complex thing apart, and the wonder grows when we consider that the average postmortem operator and pathologist has about equally clear ideas about the brain and the telephone business or cauliflowers. Perhaps it is fortunate that what is required at a postmortem is generally a very elementary sort of proceeding.

The rough examination that is possible resolves itself into a study of the membranes, the circulation, gross lesions, and diseased areas, with more or less care in preserving parts for anatomic or pathologic investigation.

It is not possible to combine all these different phases in any single brain, because it is necessary to destroy the relations existing in order to bring certain parts into view, but one can so limit one's investigation of detail as to secure a practical examination of the general features; but such a method will destroy the integrity of the brain so as to unfit it for subsequent anatomic study. Thus, it is better to examine the circulation and membranes in the fresh condition, but more satisfactory results are obtained in section work on the hardened brain.

One cannot wait to harden the brain in medicolegal cases where injury has occurred, nor can one sacrifice the main object of such an examination—that is, an understanding of that injury for any anatomic or pathologic investigation. The plan must be made to suit the needs of the case, and the dictum of anatomic or pathologic dissectors can safely be ignored.

There have been several methods proposed for approaching the brain, but all have included opening and reflecting the scalp and removing the vault of the cranium. The usual cut of the scalp is one extending from behind one ear up over the vertex and down behind the other ear. This is varied slightly at times; thus, in bald-headed persons it is suggested to make the cut as far back as possible, and it has been proposed to make it include all the bald area, though the advantage gained by making the cut invisible is lost in a measure, because such a cut is apt to leak and soil the pillow on which the head rests. This, however, may be avoided by properly treating the cavity of the brain case.

In making this cut it is better to cut from within outward, as fewer hairs are cut. Standing at the left side of the body, the knife is entered, blade up, behind the left ear, and at such an angle that the point almost rests on the skull. The knife is then pushed through the scalp, passing up and across and down to a point back of the right ear.

The hair may be parted before commencing, or by making this cut in sections or lengths, and bringing the knife out and turning the back

FIG. 119.—THE SCALP CUT.
The hair has been parted and coiled.

FIG. 120.—THE SCALP FLAPS REFLECTED AND THE WEDGE-SHAPED CUT IN THE SKULL. The occiput and neck are supported on a block that is of particularly good shape. Note specially the beveled edges and the base piece.

outward, it separates the hair, which may then be gathered into two bunches, one to each flap. The care of the hair is particularly important

in women of advanced years, and it should be remembered that light-colored hair may be stained by blood in an undesirable manner. The two flaps are dissected from the skull and reflected. In doing this the knife is held so that the blade is nearly flat against the skull, and a swing of the forearm, accompanied by a pronation and supination, allows the blade to follow the contour, cutting back and forward much as one would hone a knife on a stone, or the cutting may be made only in one direction, in which case it is made from right to left.

Greater freedom of motion and view is obtained while reflecting these flaps by standing facing the top of the skull with the head raised on a firm block, though conditions may not permit this. While cutting or peeling off the scalp it is necessary to exert considerable traction, and in certain scalps of weak texture one may cause a ripping by ordinary

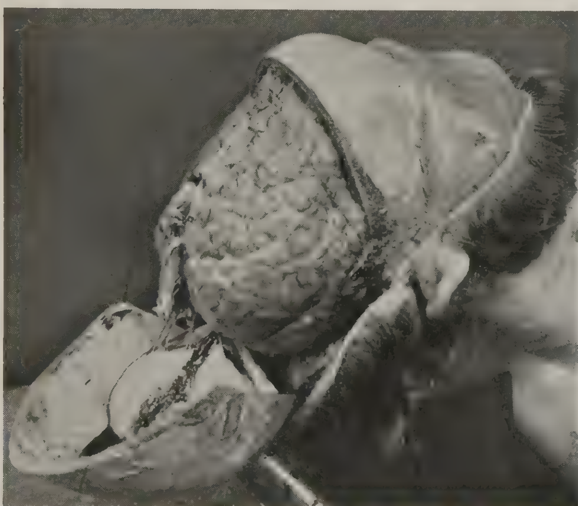

Fig. 121.—The Skull Wedge Hanging by a Piece of the Dura.
Note the settling of the brain as shown by the line, which was made while the skull-cap was in place.

force. At times one finds a scalp that strips off by pulling and manipulation without cutting after the first cut has been made.

The bone cut will be made in such a way as to avoid, as far as possible, disfigurement in private and official work, but in dissection this may be disregarded. The circular cut that passes nearly horizontally just above the brows is commonly used for anatomic work because it gives great freedom in removing the brain, but for general work the wedge-shaped cut is much better because it allows of better repair, does not permit such easy slipping after repair, and gives ample room, particularly if the brain is sectioned *in situ*.

In sawing, one has better control of the tool by standing a little sideways, with the side of the saw-hand away from the body. This allows the upper arm to describe an arc to the front and to the opposite

side, while the elbow never gets far from the body; but one should learn to use the saw at any angle, in any direction, and in either hand.

For anatomic work the saw must not be allowed to cut into the brain, but for medicolegal or routine work I recommend the section of brain and cranium together.

When I am in doubt as to the lesion or type of case I sometimes make the wedge-shaped cut of the cranium and remove the bone, and then, after inspection, remove the wedge of brain.

FIG. 122.—THE SAW-CUT LINE, SEEN IN FIG. 121, HAS BEEN FOLLOWED BY THE SECTION KNIFE.

The anterior lobes are cut so as to show their structure more fully than would be the case in either horizontal or transverse sections. The lateral ventricles are opened and the posterior lobes are well displayed. Note the highly fibrosed branches of the right middle cerebral artery.

The value of carefully sawn sections of the brain in position has of recent years been so clearly demonstrated that one does not need to take up all the details of the usefulness of the method. The construction of the brain being built up on a curved base, which has a tendency to coil or increase in curvature from the medulla forward, the paths and their stations or nuclei are on a partly radiating plan. This has not been sufficiently recognized in the plans for sectioning the mature brain, if it has, even in embryologic work, received its full consideration.

It is, therefore, structurally indicated that cuts had better be made perpendicular to the surface of the basal curve and in a plane that passes through a center or focus of that curve.

The old method of slicing the brain like a loaf of bread has served its purpose at times, and now and then it may be employed, but it clearly is not the ideal way to investigate a curved organ.

One would not wittingly cut the spinal cord on a slant in preference to cutting it straight across, and the very same reasons hold in cutting

Fig. 123.—The Frontal Lobes Reflected. (See Fig. 122.)

The surface veins are seen lying in the sulci and not rambling aimlessly about. They are moderately filled. The large arteries are not seen, except the cut ends. The only cutting needed was about the carotids and optic nerve. The fifth nerve-root on the left is clearly seen.

the brain in planes corresponding with its construction. Having cut the brain in every direction, I find that the wedge cut is the best general one, but there are cases where it is better to use one of the other methods.

Whatever method is used will have disadvantages, and all cuts make it more difficult to trace the circulation, and the study of the circulation in detail is often of the first importance.

It is surprising to see how many conditions in the brain are dependent on variations or disturbances of the blood-vessels, and it is no less surprising to see well-trained neurologists become enamored of the brain

substance and ignore the perfectly patent relations between vessel condition and brain lesion. I shall never forget dissecting out a diseased

FIG. 124 shows the value of the wedge cut in a case of advanced postmortem change where the brain is so soft that it would be impossible to remove it by the usual method. This picture shows the structure, though the consistency was that of mush.

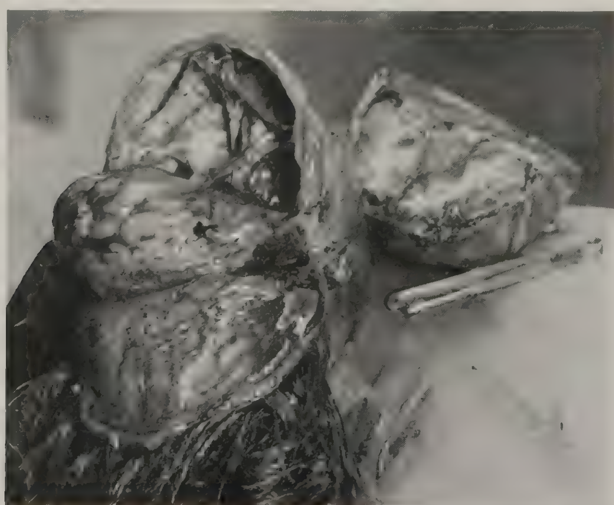

FIG. 125 shows the anterior lobes reflected and the way the substance settles; also the way the dura falls away from the skull. (Compare with Fig. 4.) Note the deep staining of the scalp, which might be readily mistaken for a bruise.

vertebral artery that had become occluded by a slow process and had caused a cerebellar atrophy—the picture was a most beautiful one. I took the specimen to a noted neurologist for his collection, and after

impatiently listening to my explanation of the position of the parts he scornfully ripped off the artery and threw it into the waste-jar. With a remark to the effect that the vertebral artery had nothing to do with the cerebellum, he captured the specimen, ruined it, and made a mystery out of the origin of the atrophy. The sublime stupidity of the proceeding stunned me for a few minutes, but it taught me what I have since many times had confirmed, that the nerve-tissue specialists are not to be trusted beyond nerve-tissue questions, and that they neglect the membranes and vessels and the mechanism of the circulation to an appalling extent.

They are, therefore, not safe guides for those who have to reach true conclusions regarding cause and effect in brain conditions, and in

FIG. 126.—A STAB WOUND OF THE BRAIN WITH RESULTING SCAR.

There is marked contraction, considerable congestion, some staining by blood, and purulent meningitis. The scalp wound is also seen. The left dural flap is seen turned to the right. The extremely thick tables of the skull are so white as to appear retouched. This picture is No. 1 of a series made of the same case to show the method of studying such a case.

matters of brain injury, associated with injury to the bones and resulting from violence, few have made even a beginning. The problems that present themselves at the postmortem, and which are to be solved there and there only, require a study of all the tissues and structures in their situation, and a subsequent laboratory examination of parts will in nowise take the place of proper careful intelligent work and observation during the dissection. All dissection is dissociation and destruction of relationship, and one must closely observe while one dissects and destroys, or one will only increase the mysteries.

Another illustration of this neglect to observe properly the relations

occurred to me. A neurologist had made out a marvelous set of symptoms which evidently inclined him to discover a new disease of the spinal cord. On dissection I found an old fistula in ano, with burrowing of pus and invasion by growth through the tissues of the micro-organism along the retroperitoneal space to the upper lumbar region. The nerve trunks were involved in the process, and yet my eminent

Fig. 127.—No. 2 of series. The saw cut has been followed by the knife. Note the clot in the deeper part of the wound; also the dots of bleeding where veins have been cut. The convolutions are seen to be flattened. (Compare with Fig. 126.) The posterior horns of the lateral ventricles are distended and inflamed. (Compare with Fig. 128.) One can judge of the force necessary to inflict such a stab wound after studying the skull.

friend was utterly unable to comprehend the patent fact that the rare symptoms were due to septic neuritis.[1] Such extensions of inflamma-

[1] It may be noted that while this work was being written, and after this paragraph was finished, my neurologic friend published an account of this case, giving not a little space to a truly interesting discussion regarding shock as a cause of the condition, mentioning, but clearly not adopting, the "theory" of infection, and subsequently he informed me that he did not recall that there was a fistula. This publication occurred over eight years after the postmortem—my report was called

tory processes are by no means rare and can be studied only at the postmortem, and never on the fragments selected for section in the laboratory. It is of the utmost importance, therefore, that whatever plan is adopted for opening the brain, or studying any part of the nervous system, the condition of the surrounding and adjacent structures be determined with great care. I am forced to lay great stress on this because of a too great disregard of the surroundings of the brain in the ordinary routine work, and to insist that the accepted method of tearing out the brain as a mass after a superficial view of the top of it too often destroys evidence of great value, and at times of such significance that a true judgment cannot be made after it has been destroyed.

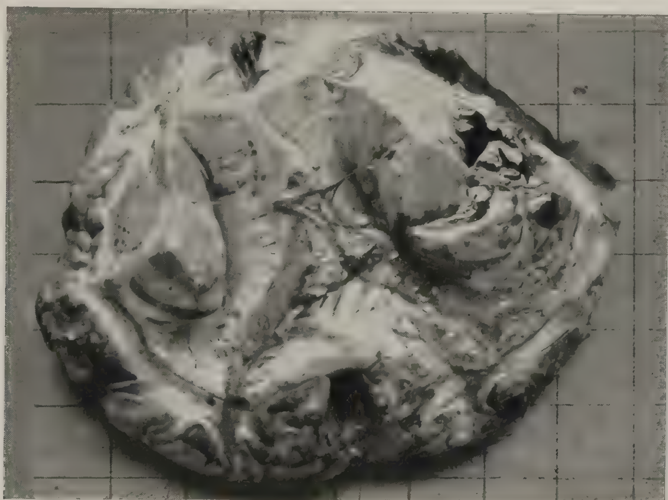

FIG. 128.—No. 3 of series. The under surface of the wedge of brain substance removed from Fig. 127. Owing to the soft condition it has settled and the lateral ventricles gape widely, but they were greatly distended with purulent fluid. Something of the inflammation is seen. Note also the clot in the wound.

To avoid this destruction of the evidence that is to be discovered at the base of the brain I adopted the wedge-shaped cut of the skull and brain.

The figures show this cut in a number of different cases and conditions.

In cases where the brain is soft its removal in a single mass is often difficult and generally accompanied by serious laceration, and in such cases the wedge method offers the only possible chance of success because the wedge is sustained by its attachments and is lifted out

for within as many days. The reason for the delay given to me was that at the time of the postmortem the best neurologic authorities did not hold that such infectious neuritis could occur, but that recent investigations seemed to point to the possibility. It will easily be seen that the practical man, who has to get results in a reasonable time, must have far different models and must adopt entirely different methods.

with ease, while the two remaining segments can be reflected gently so as not to strain the basal connections, and the relations can be studied as well as the nerve-roots and blood-vessels.

The only disadvantages are the destruction of a thin area of brain substance by the saw and the leaking of the fluids in the ventricles and sinuses.

The separation of the brain from its great cable connection below can usually be made at the level of the tentorium cerebelli, or, if this is

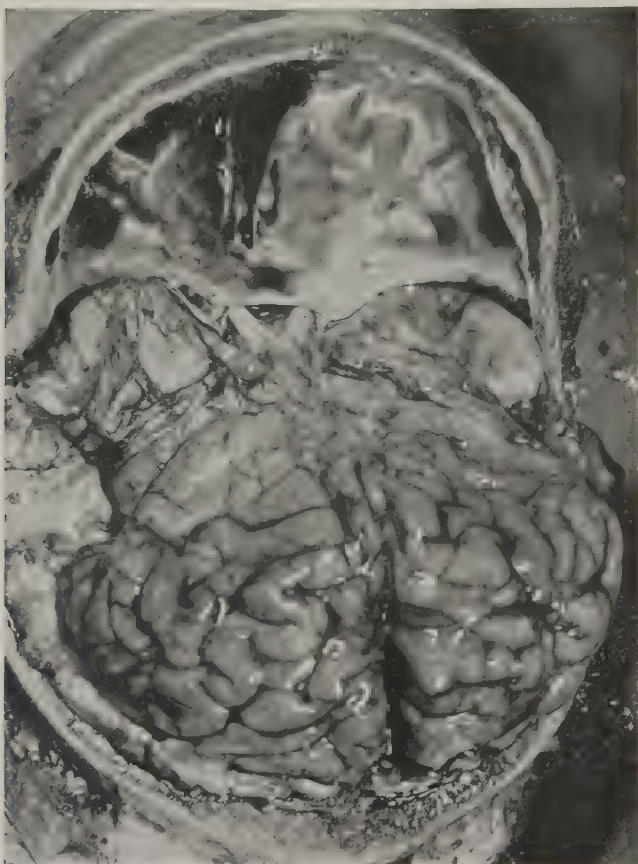

Fig. 129.—No. 4 of series. The frontal lobes turned back. (Compare with Fig. 127.) The anterior fossa shows hemorrhage (clot) adherent to the dura in the left side. The distribution of the middle cerebral artery is well shown on the left, as well as the relation of the carotids and optic nerves, and the way the anterior cerebral arteries arise and disappear between the frontal lobes.

contraindicated, either by findings in that region or because of desired anatomic studies, the section may be made at a lower level, either in the pons, medulla, or the whole cord may be removed with the brain; but this latter way is seldom desirable except for demonstration work.

Too little account is taken ordinarily of the damage done to the dura

and brain in pulling off the bone segment, and too much traction is generally made on the vessels and nerves when these violent methods are employed. The use of hammer and chisel to break the skull and of hooks to tear off the bone generally changes the distribution of the blood in the vessels and of the fluids in the membranes, nerves, and ventricles. I find that the surface of the brain and the condition of the

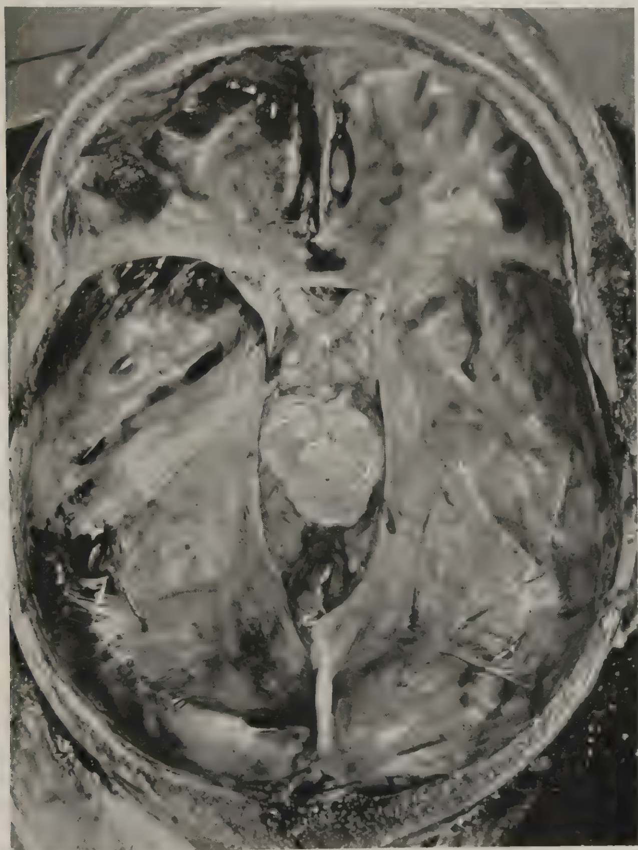

Fig. 130.—No. 5 of series. The cerebrum has been removed. The distribution of adherent clot is well seen in the left side. The tentorium is seen to terminate at the sides of the optic nerve. Its architecture and felted texture are well shown. The veins that pulled out are seen specially well in the right side. The tentorial window is striking and is in curious harmony, structurally, with that over the pituitary.

membranes can be studied better and with less violent disturbance by the gentler method of sawing, at least through the dura.

When to cut by the wedge method:

(1) When the brain is soft or decayed.

(2) When pus or inflammation has spread over the surface and rough handling will change either its position or the condition of the evidence of inflammation.

(3) In wounds of the brain, when the resistance of the brain has been lessened and the path of injury is ready to break down, and, therefore, support is needed to keep from tearing.

(4) In apoplexies, where destruction has been more or less extensive.

(5) In all cases where it is desirable to study the relation of the exterior of the body and the interior of the brain. This is specially found in wounds of all sorts, where orientation is much easier and surer when the parts are *in situ*.

(6) In serious involvement of the meninges.

(7) In affections of structures about the base, such as are found in hydrophobia; extension of infection along the nerves, as from the ear.

(8) When the cerebellum is involved and is to be studied with relation to the tentorium, vessels, and the nerve-roots.

(9) When the pons and medulla are to be studied and straining is detrimental.

When the wedge cut is not desirable:

(1) When abscess or soft tumor cross the planes of the saw cuts and will thus be opened.

(2) When extensive microscopic work is to be carried on in the region where the saw cuts would pass.

(3) When minute bacteriologic investigations are to be made, specially of the contents of the sinuses or of the ventricles; but where work is to be done about the base it is a help rather than a hindrance; but if cultures are to be made one must not saw into the dura, though the section can be made, after the cultures have been taken, by a brain knife.

(4) When the superficial veins of the top of the brain or the longitudinal sinus require special investigation.

The greatest usefulness of the method lies in cases where the condition of the brain is only studied as part of a routine examination, and then the great ease and quickness with which a good saw can be passed down in two cuts and the whole brain viewed is certainly a great advantage, for one should be able to complete this cut in ten minutes from scalp cut to removal of the brain. Rather less than the usual time for the old method.

Other cuts. At times it is necessary to make special openings in the skull. Specially is this the case in serious woundings. The cut to be made will entirely depend on the extent and position of the lesion. In extensive fractures I join the ends by a series of saw cuts, so as to lift off such parts of the skull as will give me the desired view without disturbing those parts that I wish to study.

Where extensive injury is done to the skull it is desirable at times to open a window in the uninjured part and remove the brain by well-considered morcellation. The use of the trephine has been recommended for exploration of the brain. I have rather extensively tested this method, but I do not employ it because I believe it is too palpably a makeshift and is far from satisfactory.

Where a perfunctory examination of the brain is called for, one can partly reflect the scalp and remove a triangular piece of bone with apex forward and sides of from 3 to 6 inches, with the cuts made at an angle with the surface, so that the piece of bone when replaced will fully retain its position, its edges resting on the slanting sides of the hole. Through such a cut the brain can easily be explored.

THE MEMBRANES

The membranes vary in thickness, texture, and vascularity in health very greatly, and the changes always have a significance. They show a harmony with the other fibrous structures of the body which varies with age, sex, type, and disease. Any lack of harmony of one group with the others is significant of special local conditions.

Too little stress is ordinarily laid on this harmony of similar structures in different parts of the body.

The relations of the **dura,** on one side to the bone and on the other to the brain, can be studied best by first noting the relation it holds to the brain, then removing the brain and studying the dura and bone together, then, with the sequestrum forceps removing the dura from the bone. The distribution of the dura will be found to vary greatly in different types, and the study must always include the reflected folds not in contact with the bones. One should not overlook chronic thickening which encroaches on vessels or nerves, specially about the base. The thickness, fibrous felting, congestion, degree of adherence to the bone, and evidences of inflammation will be noted while it is being viewed and removed.

The **pia** and **arachnoid** will usually be taken together, and with the contained vessels and fluids form a very important group of tissues.

The **cerebrospinal fluid** certainly acts as a water-bed for the brain and its subdivisions, but it appears to have other functions that have received too little attention at the postmortem.

It is clear that the solution must either be isotonic with the vessels and the brain or have a decided chemical action on these structures. It is known that it contains certain substances that do act on both vessels and brain, and its amount cannot be reduced with impunity, a fact sometimes ignored by surgeons with serious results, not always recognized even at the postmortem. Normally, this fluid is evenly distributed, and it passes more or less readily from place to place under the changes of pressure due to posture and the pulse and respiratory impulses in the vessels.

In atrophy of the brain, as in old alcoholics, it is markedly increased, and in certain conditions it appears as a true dropsy. Its cellular contents vary, but should not be large, and its protein content should be but a small fraction of 1 per cent.

Its increase should be accounted for in general, and when this is local it is significant. Where it appears cloudy or has a marked color something is radically wrong. Its amount is difficult to estimate be-

cause it is hard to collect, and data is scarce as to the meaning of moderate variations, as well as to where it comes from or where it goes to, and its chemical and physiologic value. In fact, the field is a large and promising one for investigation at the postmortem. The freedom with which it passes from place to place varies greatly. Some wet brains retain the fluid in position for some time after removal, while others appear wet only for a few seconds after being exposed.

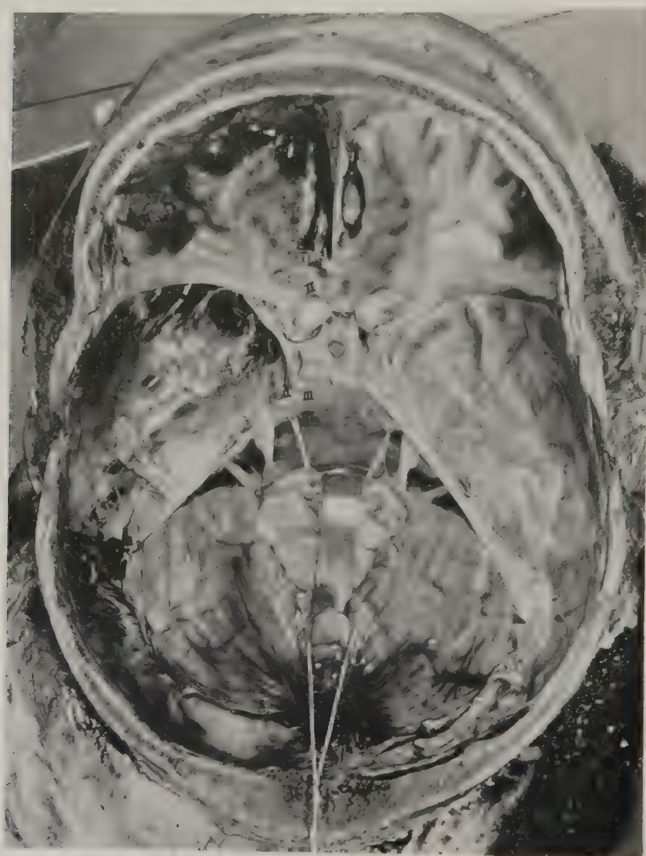

Fig. 131.—No. 6 of series. The tentorium has been cut away and the pons slightly retracted to show the nerve-roots. The ends of the optic nerve turned forward to show the close relation to the carotids. The pituitary capsule with its roof and the window in it show clearly its architecture and its relations to other parts of the dura. While the nerve-roots are put on stretch, they have not suffered as they do in the ordinary mode of removal of the brain.

In some the distribution is largely on the outer surface, in others the convolutions are separated widely, while in others the ventricles alone have an excess and their outlet seems obstructed, so that a lumbar puncture does not reveal the condition. The dissemination of infection and the distribution of pus in meningitis depends largely on the various con-

ditions that govern the freedom of movement of this fluid, and it becomes of value in estimating the age and virulence of infections.

The changes in the pia and arachnoid are to be noted at once on opening the dura, because it is common to find their condition changing rapidly after exposure, both as to blood and fluid distribution. The detail examination will be made as the vessels are studied.

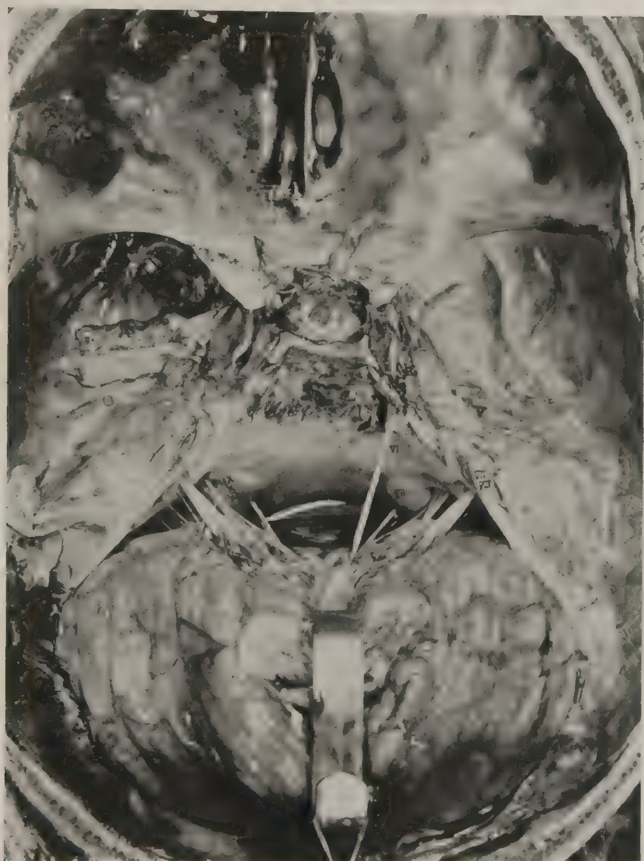

Fig. 132.—No. 7 of series. The pons has been put under strong retraction, the nerves are at breaking strain. The Gasserian ganglia are differently displayed. The roof of the pituitary capsule has been removed and the bony ridge behind freed. The empty carotid arteries are nearly in contact with the pituitary body which is seen in its seat. Something of the intricacy of the architecture of this pituitary capsule is seen, and its central position and remarkable relationship are certainly more than suggestive.

The removal of these membranes is at times made difficult by reason of the increased strength of the contained vessels which go into the brain substance, and one might mistake this for an adhesion, which condition is not common. In healthy young persons these membranes can with care be stripped off nearly in mass and floated out in water (better, normal saline solution); in older subjects with changed vessels

FIG. 133.—A LONG FRACTURE OF SKULL WITH HEMORRHAGE INTO THE SCALP.

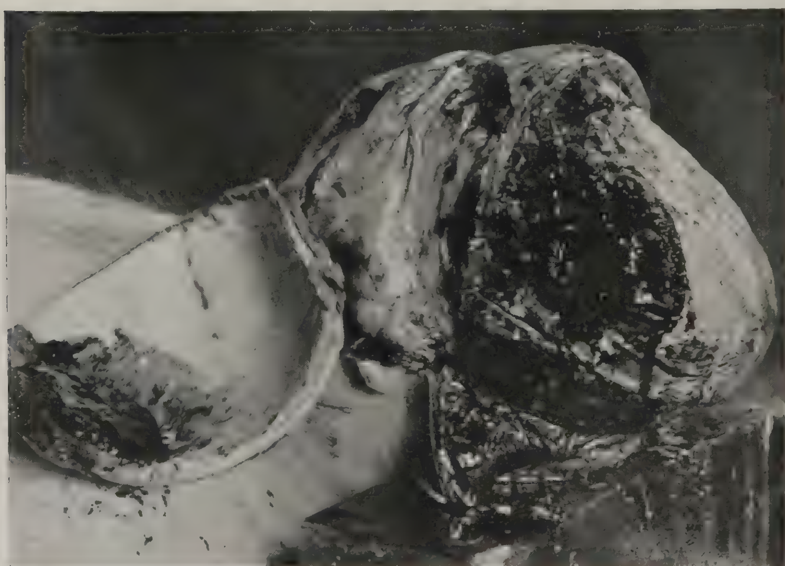

FIG. 134.—LARGE CLOT BETWEEN THE DURA AND THE SKULL.
Note the mass of clot still attached to the bone wedge at the left.

this may become more difficult. The picture of the brain before and during such stripping is most instructive, and is well represented in Fig. 149.

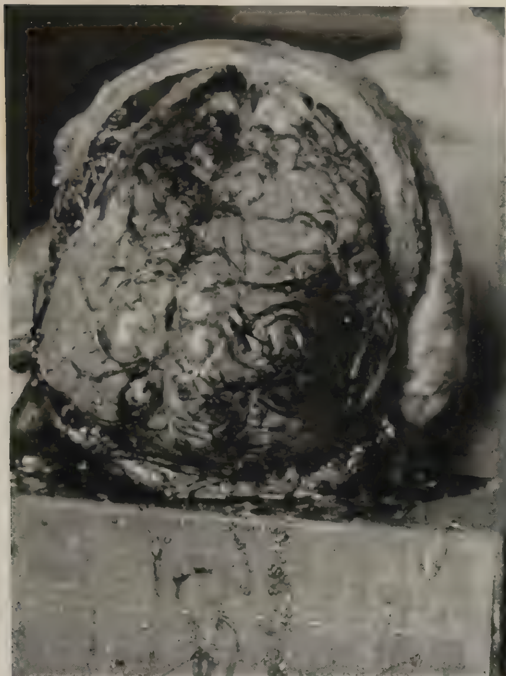

FIG. 135.—THE SECTION OF THE CLOT BETWEEN THE SKULL AND THE DURA.
Note the compression, flattening of the brain, and the hemorrhage about the brain.

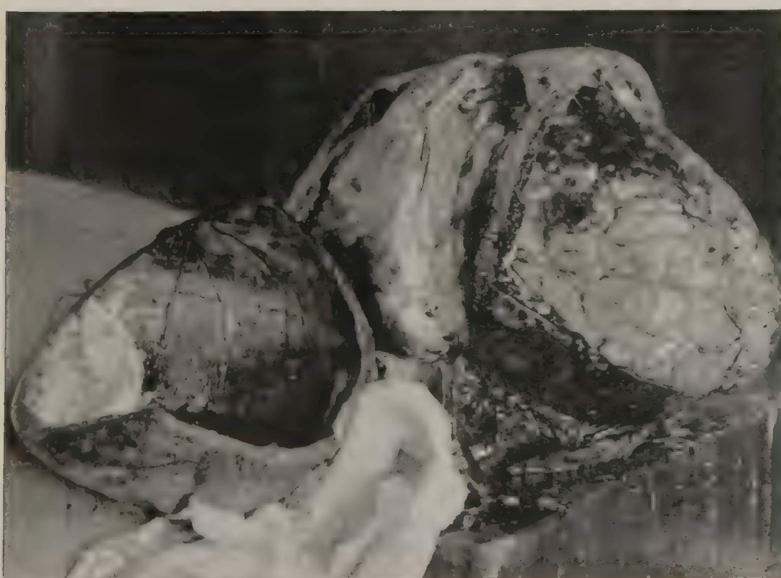

FIG. 136.—NOTE THE FRACTURE IN THE WEDGE OF BONE AT LEFT AND THE FLATTENED CONVOLUTIONS.
The fracture is seen extending forward and to the right in the frontal bone.

The degree and quality of vascularity of the surface of the brain depends on these membranes and their vessels, and it is of the utmost importance to determine these vascular conditions, as they give us our best clues in many conditions. Specially is it necessary to distinguish between congestion of inflammation and of determination, such as we find in asphyxias, and the various stages of these are to be distinguished.

Old lesions, as scars and thickenings, will often show progressive changes up to a given period, after which they remain passive, and later generally show retrogressive changes, and not infrequently one finds one process superimposed over another in chronic cases, and the finding must not be put down as one single process, but the chronology or sequence of events should at least be looked for.

One case of this sort caused me much trouble because of the medico-legal complications. Reported as a case of injury, the truth not being obtainable from the family who sought damages, I found pus over the pons and medulla and extending out to the cerebellum, but under this an old meningitis with layers of thickened felt-like membrane, with progressive choking of the circulation as it entered the medulla and pons. Finally, an old ear condition was found. After great trouble I obtained an account of his condition during life, which was of a slow, gradual change in his gait lasting over a year, and long before that a running of the ear that had entirely healed up, so far as any external evidence went, all of which amply confirmed the estimates I made while the postmortem was in progress.

Pus in the membranes requires to be studied in its relations in a far more careful manner than is customary. It is not enough to note its presence, its amount, and the bacteria present as determined by special tests, for a single drop in the sulci of a compressed brain means as much if not more than 1 c.c. in a wet brain, or one where the substance is retracted.

Cases will be found where there is only a cloudiness of the film of fluid that are just as fatally infected, and where the effect was more rapid, than in other cases where the surface was bathed in pus. In all cases where pus is found it is necessary to determine the other evidences of inflammation, and the intensity and extent as well as qualitative peculiarities.

Blood in the membranes always requires careful study. While one sometimes sees small spontaneous hemorrhages in asphyxia, in poisoning, and in purpura, blood usually means violence or spontaneous rupture of a vessel, and the location, extent, amount, and condition of such blood must be determined, as well as any indication of its age and the cause for its escape. When possible the bleeding point is determined, but this cannot always be done.

THE BLOOD-VESSELS

The circulation of the brain is so important, and the plates in the anatomies are so beclouded by the artist's fancies for decorative pictures, that I have introduced several figures which, if carefully studied and compared, will give a very different conception of the blood-supply than that presented by the strange chromos. At the postmortem it matters but little what foolish name has been attached to a part if the object is to understand the condition and the relation of cause and effect, because one must think in terms of things, not names. The circulation of the brain as described appears to be but crudely comprehended even in our best works.

The salient points of this wonderful system are well worth considering before attempting to solve problems at a postmortem examination. In all higher animals the base of the brain is carried in a horizontal plane.

The arteries come from below in two pairs, one pair deeply seated and protected through the neck by the lateral arches of the vertebræ, which pair supply the fundamental vital centers that sustain life. This pair seems to have simple sympathetic fibers for regulating the circulation.

The mind brain is chiefly supplied by the anterior pair, which come through the great neck column, and these turn sharply in the petrous portion of the temporal bone, and are so closely connected with the internal ear as to suggest the regulator function of the organ of equilibration; and these arteries are invested with sympathetic fibers, certainly suggesting equalizing of the circulation of the two sides.

This pair then passes forward and is in intimate relation with the pituitary body. In this part of its course each is anchored firmly, both front and back, to the bony walls. While the part in relation to the pituitary body rests on bone below and is restrained by tense dura on the outside, it is free to transmit the impulse of blood-pressure to that body and to press upon that body in proportion to its distention under the variations of blood-pressure. At this part there is a venous sinus (cavernous) that is capable of pressing inward on the pituitary body if markedly distended by venous pressure.

After leaving the pituitary body these arteries curve sharply and enter the brain case, but in their course they are intimately associated with the optic nerves, and it is clear that they massage these nerves by their pulsations, which appears to be a most important matter in the prevention of stasis in these nerves.

The massage of the brain by the pulsation of the arteries seems to have escaped the attention of the students of neurons, but it should not be longer neglected by thoughtful persons, because the principle underlies the philosophy of brain health and disease.

The branches of the main arteries quickly disappear from the apparent surface, and find their places well down in the sulci. Though they are in contact with the actual surface of the convolutions, they are so

placed that the blow of their pulsation is generally tempered. One can realize what this blow amounts to by studying the results of hemorrhages where the partially restraining elastic arteries have been ruptured. The chief veins are on the apparent surface. By "apparent surface" I mean the surface that is seen on opening the skull or re-

FIG. 137.—INJURY TO BROW RECEIVED BY A FALL. (See also Fig. 106.) Note the peculiarly distributed hemorrhages.

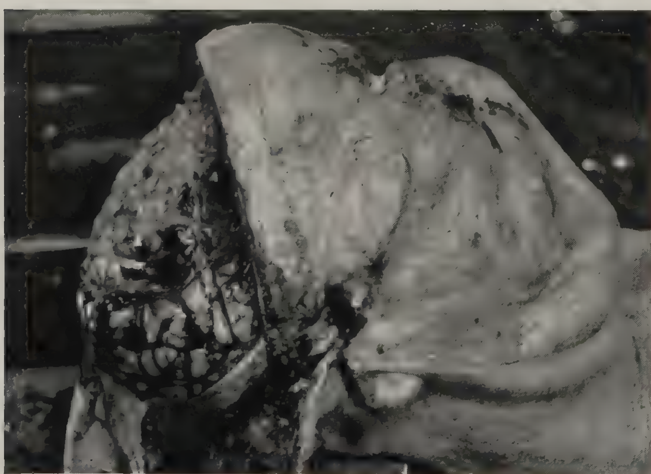

FIG. 138.—THE SCATTERED HEMORRHAGES ON THE SURFACE OF THE BRAIN DUE TO MULTIPLE RUPTURE OF BLOOD-VESSELS.

moving the brain as a whole, and in distinction from the true surface, which is vastly greater, and includes not only the crests of the convolutions, but the whole of their surface.

The relation of the pituitary body to the circulation is more than suggestive of a regulator mechanism.

I have been accustomed to demonstrate this for the past ten years, and my reasons for my belief are briefly:

(1) It is physiologically absurd to suppose that such an organ as the brain is lacking in such a matter.

(2) It is clear that the circulation of the brain is regulated by some means from actual tests made during brain activity.

(3) One would look for such a mechanism where the pressure of the vessels can be measured by some sort of plethysmograph, or pressure gage.

(4) One would look for this, therefore, at the base, where the two great arteries are close together.

(5) One would expect to find the arteries firmly anchored and their motion restricted on the sides not in contact with the pressure gage.

(6) One would expect this organ to be in such a capsule as would render its compression, by the vessels measured, constant by means of

Fig. 139.—Under Surface of Brain with Hemorrhages About Frontal Lobes and About Cerebellum (So-called Contre-coup). (Compare Figs. 106, 137, 138.)

the structure of that capsule, with part firmly supported, and windows for relief of pressure and for receiving the impulses from the vessels.

(7) One would expect this organ to be composed of nervous tissue and of glandular tissue that would affect the blood-pressure.

What we actually find is an organ that answers exactly to each of these requirements. One could not devise an organ for this purpose that more fully filled the mechanical and chemical requirements of the work, and one cannot conceive of a better location or of a more important function. The wonder is that we have gone along so many years without realizing the absolute necessity for such a mechanism, and for failing to recognize how remarkably perfect a one we have.

The recent studies in the effect of pituitary extract have made it easier to convince the brighter young man; the older anatomists are still incredulous, after their usual manner, but the clinicians are beginning to find the relations of epilepsy, brain circulation, and pituitary extract, and they will some day seek for the true explanation. In my work

at the operating table I have seen many interesting confirmations of the relation between the pituitary and circulatory disturbances and the diseases depending on them. I have dwelt on this subject because it is of great practical value, and I do not know of any place where it is adequately discussed.

The study of the arteries of the brain is best carried out on the fresh brain, and may be made in several ways:

FIG. 140.—Compare with Figs. 122 and 123 which show how this brain was removed; also with Fig. 141, which is very different in type. Note the way the basal arteries are distributed and the patches of fibrosis or atheroma; also the way the arteries plunge into the sulci and how these sulci are not open, but are closed by a considerable bridge of membrane. (Compare the character of the veins with those seen in Fig. 141.)

(*a*) The brain may be removed as a mass and the arachnoid cut with the point of a small knife over the main fissures; the lobes and sulci are then separated, and the arteries brought into clear view in their natural positions.

(*b*) This may be done in a white enameled basin filled with normal saline solution or even with clear water. This shows the nature of the pia and arachnoid, but is apt to be more tedious, as the fluid must be

renewed as it becomes bloody, and dissection under water is slower because of the surface ripples and of the refracting power of the fluid.

(*c*) The wedge mass may be removed and the frontal part of the brain laid back, when the carotid can be freed and its branches traced with great ease. (Compare Figs. 129 and 144.) The middle cerebral arteries may be further laid bare by cutting off the tuft of brain gener-

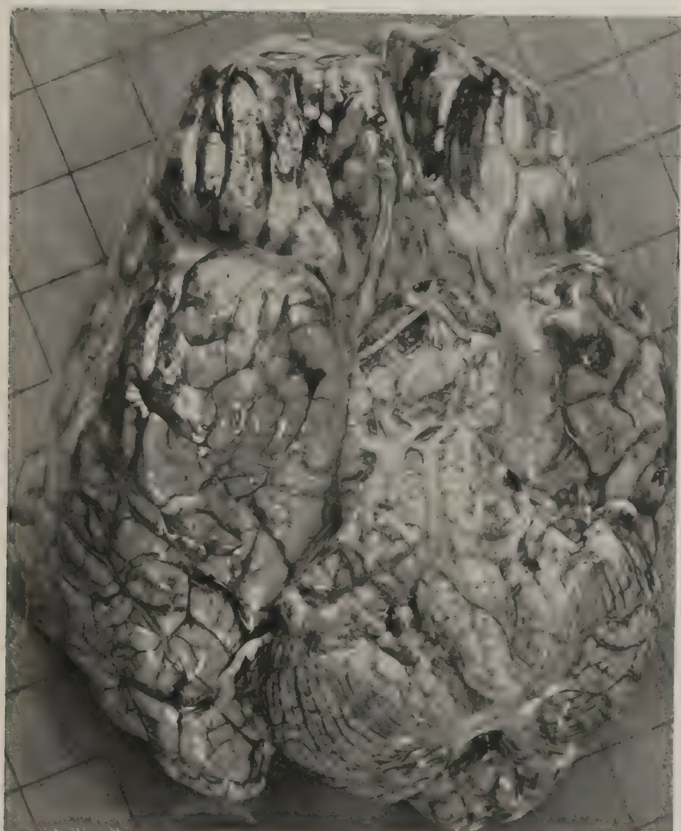

Fig. 141.—The Under Surface of a Peculiar Brain.

Note the flattening in the right parietal region which resulted from clot between dura and skull; also the bands of unusual membrane, specially in the right pontine, interfrontal, and intercerebellar regions; also several spots of hemorrhage in isolated regions. The veins are unusually straight and quite full.

ally called the temporal lobe; the anterior, by separating the frontal lobes; the posterior, by raising and turning the occipital lobes. The branches may be freed from below by following out one at a time from its beginning to its finer ramifications.

The removal of the cerebrum by cutting at the level of the tentorium, cutting this away close to the skull, and gently retracting the cerebellum as is shown in Figs. 130–132. The cord is then cut and the cerebellum

removed, when the distribution of the vessels may be studied as was done with the brain as a whole. The convolutions of the cerebellum being small and the membranes being firmer, this may require more careful handling, but the picture obtained is well worth the trouble. The carotid arteries may be traced in the base by removing the dura with the sequestrum forceps, reflecting the Gasserian ganglia, and freeing the artery in its bed as far as the petrous portion of the temporal

Fig. 142.—The floor of the brain case is here seen. The view is from above and right side. The cranial nerve-roots, *II* to *XII* ("*IV*" should appear in the figure just above the fifth nerve). *C.A.* The carotid. *Vt.A.* The vertebral artery. *T.C.* The tentorium cerebelli. *G.G.* The Gasserian ganglion. The stalk of the pituitary body is seen containing enough blood to make it appear quite dark. This is seen to pass through the partly closed tympanic window, forming the roof of the capsule in which the pituitary body is situated. The peculiar reticulated structure above the Gasserian ganglion is very well shown. The way the tentorium passes into the membranous supports of the posterior clinoid processes is to be noted.

bone. This may be approached as in the dissection of the ear, or with a small chisel and a metal hammer the sphenoid mass and the petrous portions may be removed together or on either side, after which one can chip out the canal with a very small chisel or crack the mass with a larger one. Ordinarily, it is easier and quite satisfactory to examine the cavernous area *in situ*, and to take out the petrous portion with the ear mass, carefully cutting the artery at a point beyond the chisel cut.

The minute circulation of the brain is hard to dissect, and is best

studied after the coarser branches have been inspected, and this may be roughly done by sectioning the brain. What one finds in the vessels, either in the way of contents or condition, is always important, and if the study of the vessels was more carefully made there would be fewer freak diagnoses of cerebral thrombosis.

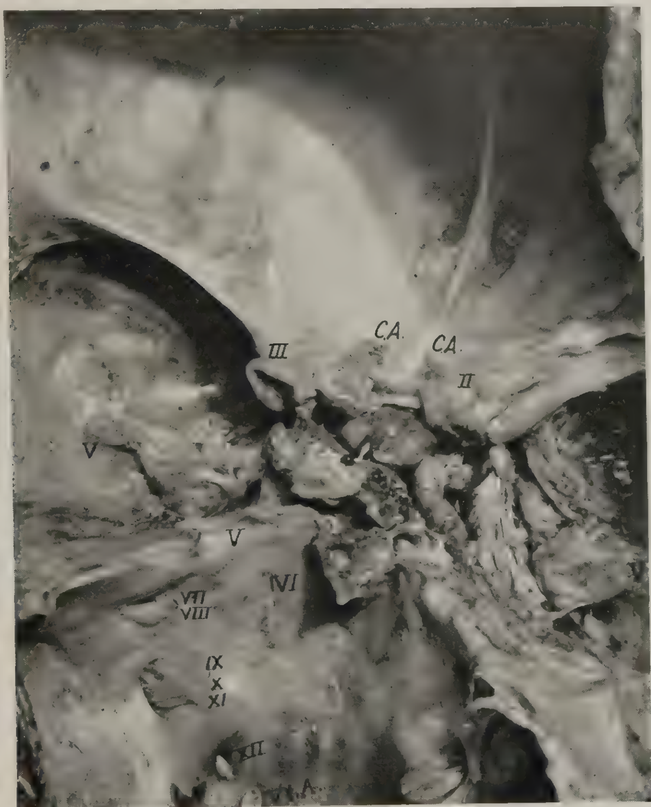

Fig. 143.—The capsule of the pituitary body has been opened by cutting away the fenestrated window or roof and, by the gentlest dissection, the right side has been cleared to show the relation of the loop of the carotid artery which is here but slightly fixed, though the lower portion in the bony canal is firmly fixed and the anterior loop is more or less anchored in place. The ends (*C.A.*) have not been cut free, but are simply turned forward over the optic nerves. The right posterior clinoid has been cut away so as to give a clear view of the relation of the carotid and the pituitary, both of which structures are in their exact positions. If the free end of the carotid be connected with a syringe and fluid forced into the vessel, the pituitary will be forced inward and upward, even though the outer wall and the Gasserian ganglion have been reflected. These, when in position, receive the outward throb of the vessels.

After the arteries begin to branch one does not find collateral circulation, and a plug in a small branch, either by growth or deposit (thrombosis or embolism), will cause a serious condition in the part of the brain supplied. If this is not a highly important and vital spot the person may live long enough to develop softening or atrophy, though

atrophy is more apt to occur when there has been constriction of the lumen of the artery by some "atheromatous" process.

Rarely one finds an aneurysm, and this may rupture. Figs. 145–147 show one of the middle cerebral that burst into the floor of the lateral ventricle.

Rupture of the arteries is common both by apoplexy and by violence. In apoplexy it is often difficult to find the source of the trouble owing to the great destruction of the brain substance by the blows of the pul-

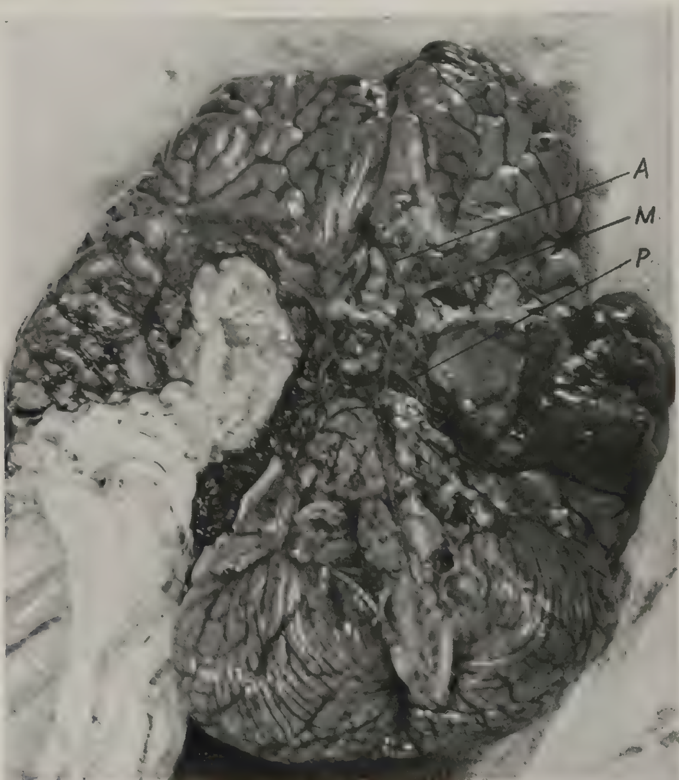

FIG. 144.—Brain from below showing how the arteries—anterior (*A*), middle (*M*), and posterior (*P*) cerebral—pass at once to the bottoms of the largest fissures and do not appear as so often pictured straggling over the surface. The right temporosphenoidal lobe has been cut away to show the distribution of the middle and posterior cerebrals, a branch of the posterior going into the choroid plexus and lateral ventricle. The choroid plexus appears quite dark owing to congestion.

sation, and later by the softening following occlusion of adjacent arterial twigs.

In violence the problems are many and various, the simplest being where direct wounds, either by penetration or propulsion of fragments of bone, have taken place. The more difficult are found where transmitted force has caused rupture. Of these, directly transmitted violence done to the cranium are most common, but those by transmission of violence through the blood columns in the filled blood-vessels are not

rare, and constitute a considerable part of the so-called "knock-out blows."

Actual tearing of the arteries is usually limited to the meningeal arteries, and the bleeding is then massive and may be in either direction,

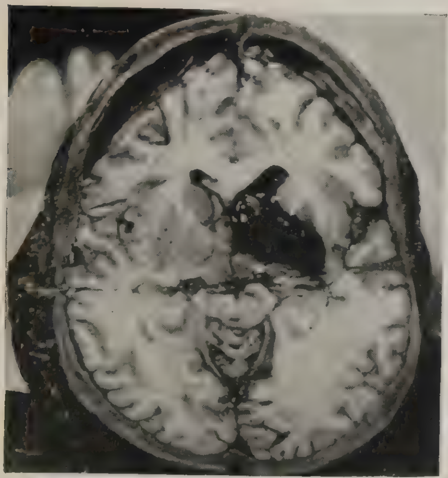

FIG. 145.

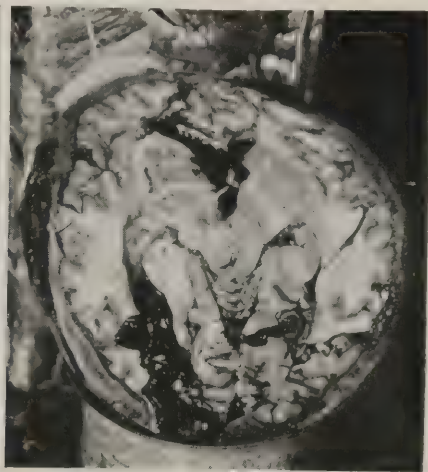

FIG. 146.

FIG. 147.

FIGS. 145–147.—APOPLEXY FROM RUPTURE OF ANEURYSM OF MIDDLE CEREBRAL ARTERY.
FIG. 145.—The clot in the right lateral ventricle, the wedge cut having been made.
FIG. 146.—The under or contact surface of the wedge, with clot appearing more extensively.
FIG. 147.—The middle cerebral raised on four instruments, the aneurysm resting on the blade of the scalpel.

but oftener between the dura and the bone; rarely it is found between the layers of the dura, and hemorrhage under the dura is generally from the vessels of the brain itself. The age, size, and condition of such hem-

orrhages are to be studied carefully and the effects are to be cautiously estimated. These effects are chiefly compression, laceration, staining, and functional disturbance. The variation in the amount of blood in the brain after death is generally a matter of venous congestion, but occasionally one finds blood in the artereis.

The veins collect toward the outer surface of the brain and empty into the large sinuses. The effects of lesions of the veins are much less frequent than those of the arteries, but their condition is more often studied, and statements regarding the state of congestion of the brain generally refer to the fulness of the surface veins. Care should be exercised in all estimates regarding the location and amount of blood in the brain not to follow this practice. Such estimates should only be made after opening the body cavity, for intrathoracic pressure will not rarely fill the surface veins of the brain while the skull is being removed, specially if the sinuses have not been opened; this in spite of theories regarding flow of blood in the veins. I have seen a quart of blood flow from the opened sinus.

Inflammation of the veins and serious clots, while not of common occurrence, may be searched for, but usually show in the area drained in such a way as to be easily detected by a sharp eye if the brain has not been carelessly handled. In meningitis the veins are apt to be secondarily affected, but I have seen it follow by extension from a vein. This is more apt to occur where suppuration or infection follows the sheath of a vein.

The membranes and the circulation offer the major part of the postmortem problems. The anatomic investigations and the study of lesions, either gross or microscopic, require special preparation and technic, for which there is not space in a work of this sort. Certain very general thoughts should be held in mind by every operator. For convenience I group these under headings:

(1) Bilateral symmetry is the rule; though exceptions are common and significant.

(2) The two halves are connected point by point.

(3) The brain is a mirror picture; that is, it is reversed, so that a sign in the right of the body is mirrored in the left of the brain.

(4) The points of crossing of the leading cables are of great diagnostic importance.

(5) Some of the cables lead into and are distributed to relay or ganglionic masses, others seem to lead through such centers more directly, while others pass between masses, and each, when located, becomes a help in localizing lesions.

(6) The vertebral arteries lead to the more fundamental vital areas where lesions are apt to be quickly fatal.

(7) The cerebellum is intimately associated with equilibrium and coördination, so that serious lesions there quickly produce incoördination, a fall to the side opposite the lesion and rapid unconsciousness, often accompanied with an attack of vomiting. Cerebellar hemorrhages are often diagnosed as poisonings, the pupils often being small.

The diagnosis of cerebral thrombosis is generally made in error through lack of knowledge of the circulation of the brain, and is seldom confirmed at the postmortem.

Lesions of the brain substances, such as tumors and gummata, are generally better studied after being hardened, after the art of the histologist, and should be carefully removed and preserved. While removing, the relations to blood-vessels and to the brain landmarks should be noted. Abscesses often involve adjacent structures, and in such cases it may require great care in dissecting, as it may be necessary to remove parts of membranes, bone, or even adjacent organs in mass before attempting the dissection. I find that it is often advisable in such cases to carefully remove sections or blocks of the unaffected part of the brain

Fig. 148.—The Basilar Artery of a Brain that Has Been Dissected from Above and Reconstructed.

In this artery is a large clot which plugs the lumen where it branches. The posterior cerebral artery is seen coming directly from the basilar. There is marked venous congestion. (I am under obligation to Mr. Milton M. Bergey, of the Pennsylvania Hospital, who kindly took this picture for me.)

in such a way that reconstruction is easy. The objections to this method may be obviated if these portions are cleanly cut, and the cuts are so made as to make reconstruction complete and simple, and the direction and extent made with reference to the anatomy of the parts cut and the needs of the investigation and the technic to be employed. Such blocks, if properly handled, can be hardened readily because the fluids have more easy access to the tissues.

The study of the brain substance constitutes such a highly specialized branch of anatomy that we can with difficulty select what will prove of most general value, for there is no part of this enormously intricate system that is not of interest and importance, and each part requires its own special dissection, which more or less destroys other parts.

It is clear that we must study the *surface* in all cases. Here we observe the relations with the blood-vessels and membranes and all changes associated with these structures. The general geography of the brain was studied long before its physiology was faintly guessed at, and the names given to the parts are consequently rather worse than unfortunate at times. So much time and energy is wasted in learning these foolish names that had better be spent in understanding the fundamental ground-plan and the significance of the structure, that the average medical man finds himself overwhelmed with nomenclature and details.

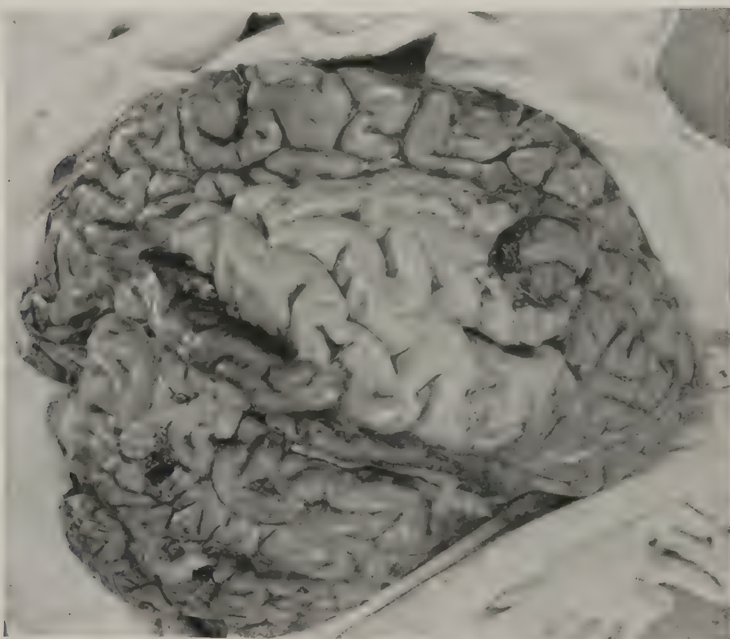

Fig. 149 shows what is not only justifiable, but at times necessary: stripping off of the membranes in order to study the convolutions. The membranes are gently grasped and freed by pulling in such a way as to put the greatest tension on the attachment and least on the membrane itself. It is seldom necessary to use an instrument, but if the small vessels entering the brain substance are fibrosed, they should be cut. Note the depth of the grooves and the peculiar folding of the ridges. (Compare the plan of securing the maximum of surface as here developed and the blood-supply with the plan in the intestines.)

I cannot conceive it possible to make any attempt at understanding the brain as a mechanism which does not combine a thorough study of brain physiology and psychology with brain anatomy and pathology. Nor can I see how a reasoning person will attempt to so separate structure and function as to build up in his own or in his pupils' mind any conception of this structure without first laying a foundation in physiology. Much meaningless literature has resulted from an entirely unreasonable dissociation in the past. To study a watch or a ship or any machine in a similar way would certainly not be considered as a sensible proceeding, and why we should attempt to study the

most intricate of all machines in a way that must handicap us is a mystery in spite of our realization that it depends on the accidental historic development of the study. To attempt to comprehend masses of cells and fibers without the clearest understanding of what is known of nerve force, how it is generated, transmitted, reinforced; something of automatic and rhythmic variations of the nerve impulse traveling along paths; something of how potential is raised before a wave can be started along a nerve path, and how such potential is excited, maintained, and varied, and how the impulse when started passes to definite places along known paths until it reaches stations. What takes place in such stations either in the way of automatic changes, reflex effect,

FIG. 150.—The left lateral ventricle is laid open so as to show the smooth lining, the choroid plexus, the surface vessels, and the lining of white matter. (Compare with the various photographs which show them cut across and with clots in them.)

or reinforced transmission or fixation of impression or conversion into tissue memory, which is but another name for transmutation of force into structural change. Something of the bilateral symmetry of the machine and its significance, and of how the surface of the body is absolutely mirrored in the central organ in such a way that every special sense, as well as the higher mental segments, are in such intimate connection that coördinated thoughts and acts are made possible. Something of the absolute necessity of a multiplicity of connecting paths which will render possible such thinking and acting quick, clear, and of proper degree of force. These are the barest elements of what is necessary for a beginning.

No true realization can be had without a larger grasp of the way the sense perceptions, the memory records, and the motor impulses which constitute the simple basis for brain action all find their proper place.

The study of the brain at the postmortem demands a knowledge of the larger clinical history; not simply of the pathologic, but of the normal peculiarities of the case.

While our work must be relatively crude, we should not forget the great problems, and seek only for perfection of details along some recently developed special line of study, even though such study is of the greatest value and throws light on hitherto dark and unexplained phenomena.

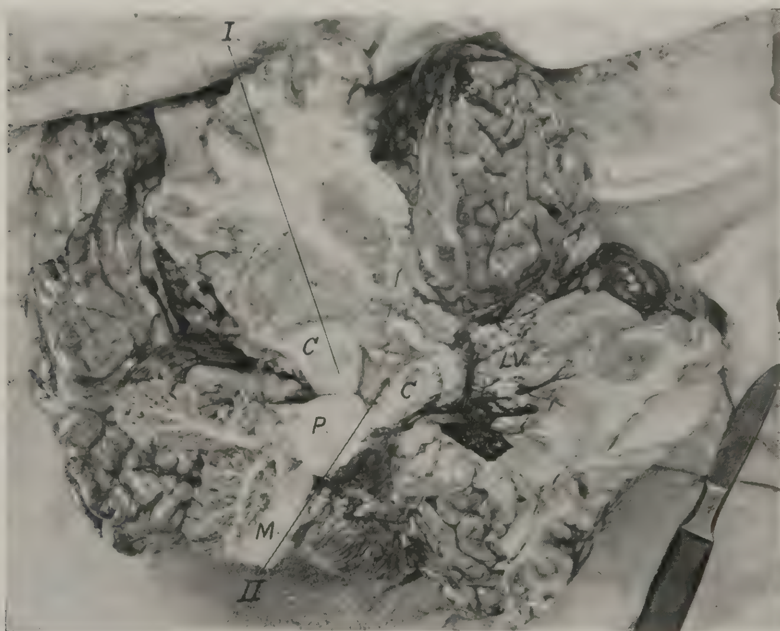

Fig. 151.—Under Surface of Brain.

The pia and arachnoid have been removed from the right side of crus (*C*), pons (*P*), and medulla (*M*). The right cerebellum has been cut in a vertical plane. A horizontal section made from the crus forward on the right side. A curved cut on the left has opened the lateral ventricle to show the choroidal branch of the posterior cerebral artery. The parts forming the fissure of Sylvius have been separated to show the middle cerebral artery. Lines *I* and *II* show where cuts are made in preparing Fig. 152. (Compare Fig. 144.)

So far as possible we must keep pace with these innumerable little bits of progress which are slowly helping us to a true understanding of the brain, but at all times it is our duty to fit these into an orderly systematic conception of the organ as a whole. The tendency to neglect the gross appearance of the parts of the brain should not be permitted, simply because from such gross study in the past we failed to discover things which we learned from other sources. At the postmortem our immediate task is to study the gross appearances and to appreciate the significance of variations found. There are many prob-

lems which can be solved by this sort of work which are too important to be neglected that are not to be solved in any other way. Our greatest difficulty will be to select the proper method of procedure so as to gain the greatest amount of information in each case.

At times we will have to put the whole problem on the shoulders of the histologist, and we will then be guided by his methods in removing, cutting, and preserving the organ. At other times such a procedure will not only be unnecessary, but distinctly wrong. We must gain our ends by appropriate means.

The size of the brain still has importance, in spite of the knowledge that quality and condition are just as important. The shape depends

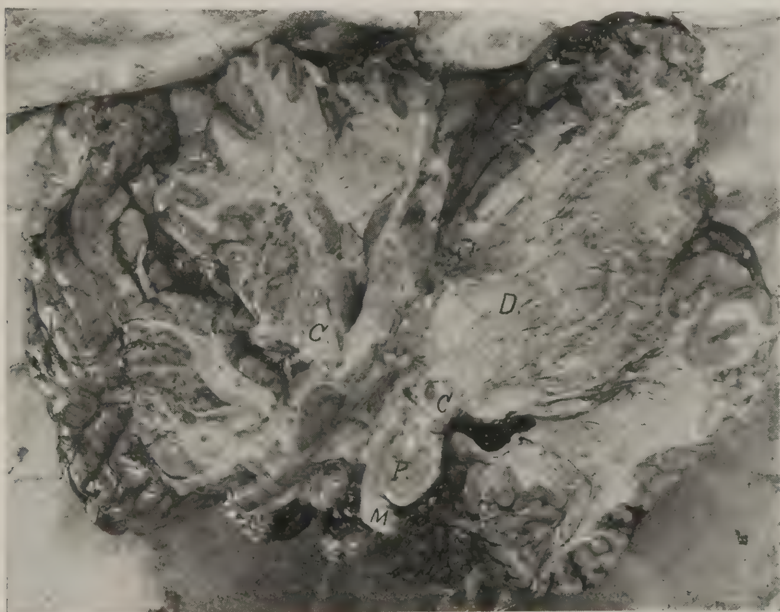

Fig. 152.—Along the line *I*, Fig. 151, a vertical cut was made to open up the structures spreading out from the right crus. Along the line *II*, Fig. 151, a vertical cut was made in the midline through pons and medulla. From the crus a horizontal slice was removed on the left side and the substance gently scraped. The general radiation of fibers is thus accentuated. These figures will be offensive to those who think only in the realm of histology. They are intended for those who have to investigate problems that must be solved quickly and who have no time for neuropathologic reports which are made only after years, if at all, and then are fringed with ultrascientific doubts.

not only on accidental developmental limitations set by the skull, but on the relative size and condition of the various parts.

The large cerebellum of the cat is no more significant of high muscular coördination than is a relatively large one in a man. The general symmetry of the brain is seldom carried out in detail, and yet great asymmetry is generally associated with mental imbalance.

The actual condition of the tissue of the brain substance is difficult to determine because observers have neglected to properly accumulate data as to such variations and their association with functioning.

This can only be overcome and corrected by a larger and more reasonable practice in the future and a standardizing of the basis of such estimates of conditions found. The relation of softness to youth is well known, but what its relation in the adult to bodily condition is far too vaguely realized except where pathologic softenings are found or when we find either vascular change or actual tumor.

The cortex varies in complexity in such an endless number of ways that cortex geography has become a sort of specialty in itself. We cannot finish our work and complete a study of the brain in reasonable time limits, but we can give a few moments of thoughtful attention to the general type and condition of the convolutions, and often with immediately profitable results and always with benefit. Note specially the manner of folding of the convolutions and the way they are crowded, and the degree of fixation by the membranes. Compare the cortex with the brain case, and see how far the sculpturing of the two correspond, and how the parts of the brain fill the details of the surface of the bone, as any departure from a correspondence of these two structures is of significance. In old alcoholics one often finds a shrinking of the brain and a large amount of fluid. In local atrophies of disease or in swellings there is often displacement. Such lesions are usually associated with symptoms that should have been noted in the history. Note the texture of the brain, remembering that this organ is extremely sensitive to the general chemical conditions which depend on the other bodily organs, and the color and texture of the brain should be compared with the other organs.

The remnants of the central canal, as found in the various ventricles and the connecting channels, form a most interesting and important group.

These spaces are often the seat of serious changes that are of the utmost importance. I have been unable to find an adequate discussion of them.

A question that I have often asked and to which I seldom receive an answer is, Why do the lateral ventricles exist? Unless one is ready to not only explain what they are, but what influence they have on the life of the brain, it would be well to begin all over again to study the architecture, physiology, and pathology of the brain. Consider well certain features of these areas:

(1) The extent; (2) position; (3) relation to surface of the cortex; (4) their smooth surfaces; (5) their blood-vessels; (6) their influence on the mobility of the brain, part on part, open one and move the brain; (7) the way they are drained; (8) the way apoplexies reach them; (9) the diseases that affect them; (10) their influence on the adjacent tissues; (11) their relation to the distribution of white and gray matter.

After these considerations draw your own conclusions as to the failure of most writers to discuss their nature and significance. Mine are rather too radical to look well in print. The study of the great masses of white and gray matter or, as I prefer to think of them, of transmission systems and stations, is far beyond the limits set for this work. I can

only urge that they be considered as functioning mechanisms rather than unfortunate objects that have received monstrously absurd names from the densely ignorant fathers of anatomy. The dissection of these should be guided by such mechanical understanding as is available. I have taken the brain apart in so many different ways, and have learned something from each method, that I am not willing to say that any one is wholly bad. Perhaps the only way to gain a full grasp of the parts is to make a complete set of very thin serial sections and to reconstruct each area. This method is entirely beyond the range of ordinary postmortem work. We must be content with the best possible makeshift carving in order to display the tissues we are called on to observe, and the least valuable of these is the usual slicing and the most useful is opening out the parts so as to display them and their conditions.

LESIONS

The great frequency of wounds and of infections, of apoplexies, and of changes in the membranes make their study the most important part of the average postmortem of the brain.

The investigation of conditions found in the insane is a specialty which we must cultivate as far as possible for general work. The study of brain tumors is another specialty. In general work we must have sufficient knowledge of the parts to quickly recognize lesions, whether degenerations, tumors, or developmental anomalies, and what to do with such lesions in order to prepare them for more extended study. The dissection of such lesions should be limited to the determination of their presence, their general condition, size, position, and what structures they affect. Their preservation is to be carried out along the lines developed by the art of the special anatomist. Infection of the brain substance is rare, except in cases where some infection has entered the brain case and affected the meninges or has been carried by the blood. The limits of such infection, its intensity, and the sequelæ are to be determined and the history most carefully compared with the findings.

Certain special infections reach the brain by paths that are not always easy to determine.

Epidemic cerebrospinal meningitis shows great variations in the effect on the brain. I have seen cases where death occurred before pus had begun to develop.

In hydrophobia the only finding that I have always observed is a blush over the under surface of pons and medulla.

The channels by which infections reach the brain naturally vary with the particular microörganism. The nose, the ear, the scalp—all form the starting-point for a certain number of infections. The gut undoubtedly supplies a much larger number than is generally realized. Tuberculosis, syphilis, and the other general infections give rise to a limited number of cases, the character of which is only exceptionally a matter of doubt. The manner and rate of invasion and the type of outburst, whether insidious or fulminating, depending so markedly on the virulence of the infection and on the special resistance of the

tissue affected, it is important to balance all these factors carefully. Of the resistance of the brain itself we know far too little, so that observations in this field are needed.

HEMORRHAGES

Hemorrhages on the surface are found when blood-pressure has been increased or the chemical conditions have been interfered with, specially

Fig. 153.—A Case of Apoplexy.

The bone has been removed as well as the dura. The line of the bone-cut has been made on the brain so as to show the way the brain sags by its own weight. Note the flattening of the convolutions; the filling of the superficial veins wherever the general compression was limited. No free blood is found between the brain and the dura.

in asphyxia or purpuric conditions. Rupture of vessels may arise from direct violence, causing a bruise or a laceration. The free flow of

blood from a broken artery is apt to produce serious disruption of the surrounding tissues. If small vessels in the brain substance are broken the substance is torn; if in the meninges the hemorrhage does less apparent, but often no less real, damage. In apoplexies the mass of blood shed is apt to be considerable and compression results, along with more or less destruction by pulsation disruption.

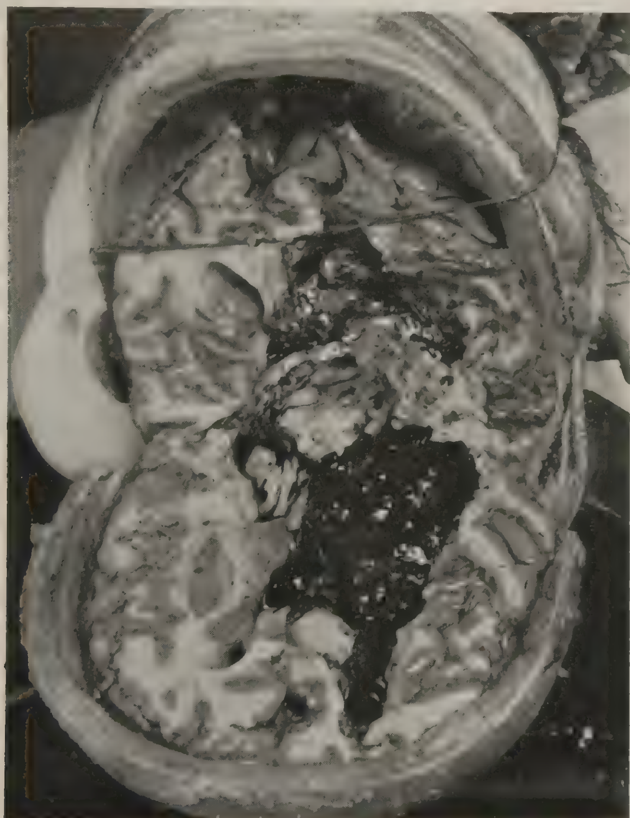

Fig. 154.—The Interior of the Brain.

The section was made by replacing the bone and passing a large knife along the planes of the bone-cut. The brain was so soft as to need support above. The floor of the anterior portion of the right lateral ventricle was destroyed. The clot in the posterior part is seen in place; the distention was extreme. Very little clot was found elsewhere, but the serum had entered the other ventricles and passages. (Compare Fig. 153.)

The illustrations show the conditions actually presented. The changes in the shed blood are similar to those found elsewhere, though clots usually occur early, and may cause staining, and as the blood changes the color passes from red to yellow or brown, so that one may roughly estimate the age of the deposit. Chemical and microscopic examination of these stains are at times desirable, but the picture is usually clear enough to the naked eye.

SPINAL CORD

The spinal cord is generally approached from the back, the body being placed face downward with care, so as not to mar the features; whether to elevate the head or not will have to be decided by the conditions. When the body has been opened, and the internal pressure relieved or the blood drawn from the veins, it is well to have the head low, because the neck can then be flexed so as to give free access to the cervical spine. This may be easily accomplished by allowing the lower surface of the under jaw to rest on a pad placed on the edge of the table. When the body has not been opened and the internal pressure is not relieved, one is apt to have annoying bleeding that is at times undesirable. Then it is best to elevate the neck on a high block. If the brain has been removed first and the sinuses freely opened, I find it best to have the body as nearly level as possible, and, if any slope is allowed, to have the neck slightly elevated. This is best arranged by placing a medium height block, well padded, of course, under the neck, and a large pad under the belly. This position tends to prevent any marked flowing of the spinal fluid.

The incision is carried from the occiput to the lower lumbar region in the midline and well through the skin. The skin-flaps are separated from the muscles for a few inches on each side; this gives free access to the lower structures and makes repair easier.

When the back muscles are slightly or moderately developed they do not need to be dissected off entirely, but may be cut from the spinous processes by cutting from either end; from below is usually easier. The knife is held so that the blade is nearly flat with the spinous processes until the laminæ are reached, when it is turned so as to cut and scrape the tissues from the bone. Here the cutting is easier when the knife goes from above downward.

If the muscles are large and great freedom is desired, they may be removed in large prisms by cutting to the ribs about 2 inches from the spinous processes, and then removing the masses by freeing them with the knife, which is held flat to the surface of the ribs.

The spinal muscles can be most easily removed by cutting them at right angles in the lower thoracic region, dissecting the thoracic section upward and outward, freeing from the ribs and transverse processes.

In freeing the lumbar segment care is to be taken not to go too deeply so as to open the abdominal cavity, unless one does this with the definite intention of obtaining a posterior view of the viscera. By grasping the upper end of the lower mass after making the transverse cut, and pulling down and outward at the same time, cutting carefully

with the knife-blade nearly flat on the transverse processes, the whole posterior aspect of the spine is laid bare and the muscle mass may then be reflected or cut away. Usually I make a slanting cut outward and toward the surface from the ends of the transverse processes, and leave the resulting muscle prism attached at its lower end in the lower lumbar region. This enables me to reconstruct for study and to replace for repair with greater ease and better results.

The removal of these muscle prisms leaves two troughs, one on each side of the spinous processes, at the bottom of which are the laminæ, which must next be cut through. This is usually done by sawing, though various sorts of shears and chisels have been devised and used, all of which are, however, to be used cautiously, if at all, because of the damage they are likely to cause. The best work can be done with a stiff saw having a convex curve, and with the teeth properly cut so as not to project sharply forward. If they point directly to the front, as is too frequently the case, the saw will surely stick in the bone. The saw cut should be made so as to enter the spinal canal at its outer edge, and this must be carefully calculated in each case. If some assurance has been gained by experience, the saw can be slanted inward so as to remove the lamina in a wedge-shaped mass, the base of which includes the spinous processes; but if such assurance is not yet arrived at, let the cut be made at right angles to the surface of the lamina.

If the cut is made too close to the spinous process there is risk of cutting into the cord, and too little space is had through which to remove it; and if the cut is made too far out it will pass through the pedicle and will not open the canal at all. If entirely in doubt as to the width of the canal, make the cut about $\frac{1}{4}$ inch from the spinous processes, so that the two cuts will be not over $\frac{3}{4}$ inch apart, and saw with great care, so as not to go beyond the bone into the canal. The saw-cut should always entirely sever the bony roof of the canal, so that the spinous processes bend readily to pressure from either side.

When all the spinal processes bend easily a cut is made between two of them in the lower lumbar region, and with stout forceps pull up and toward the head, while with the knife the few remaining attachments are severed. The whole mass of the spinous processes should separate easily up to the upper cervical vertebræ, where it is extremely difficult to reach them with an ordinary saw; they can, however, be cut by a square-tipped saw or they may be chiseled cautiously, but when the brain has been removed, and the cord has been cut well down through the foramen magnum, it is not necessary to cut the upper two cervical vertebræ, as the dura can be cut at the level of the second vertebra and the nerve-roots severed through this opening and the cord slipped out. In taking out the brain and cord together the saw cuts may be completed by using a small chisel, so held as not to drive the edge or any fragments inward, but so as to cut a groove along the surface of the bone; the force of the chisel will then not be transmitted so readily to the parts as if it is held perpendicularly to the surface. The chisel can be used throughout in cases where speed is desirable and artefacts cannot be of

much importance, but when fracture of the spine is being looked for it must not be used.

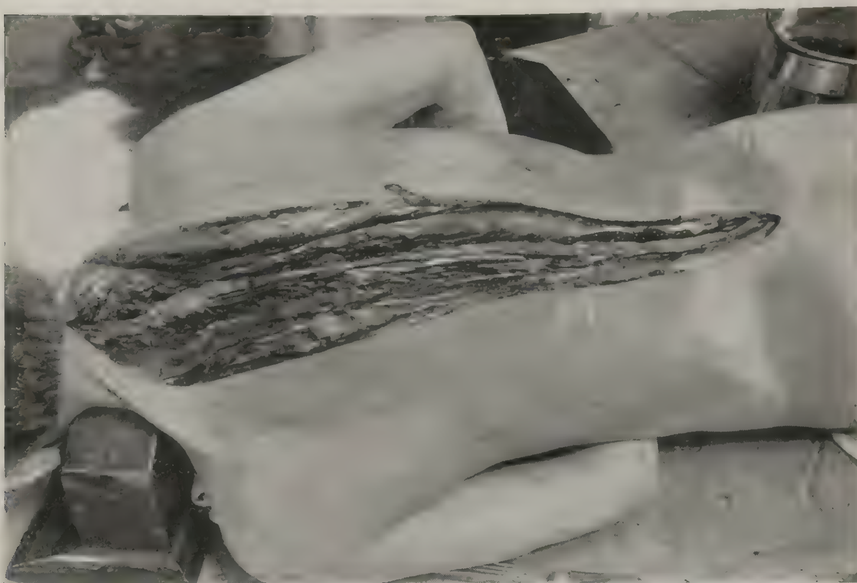

Fig. 155.—The Cut in Muscles and Skin for Removal of Spinal Cord.

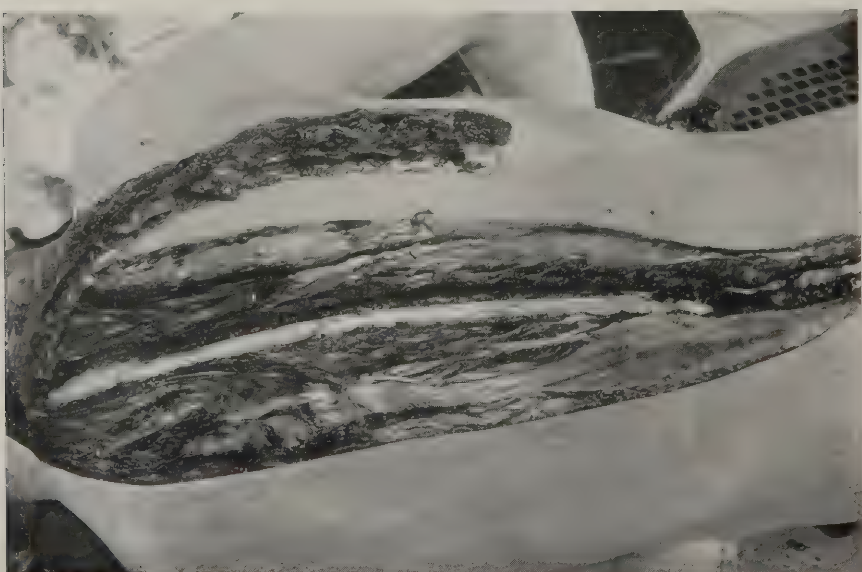

Fig. 156.—The Spinal Canal Has Been Opened by Two Parallel Saw Cuts. The bony chain is seen above, while the dura is seen in the canal.

The form of chisel best suited for the work is that shown in Fig. 39. Where the tip is armed with a round point set at right angles to the

long axis, and the cutting surface is on one side and the hammer surface on the opposite side, the point is inserted between two laminæ, and with the chisel held nearly at a right angle to the laminæ it is driven forward with short, sharp blows of a good-sized metal hammer, beginning in the lower segment of the spine and working headward. This process may be followed in the removal of the cord through the body cavities where it is not desirable to make a second cut in the back.

Fig. 157.—The Cord, Covered by the Dura, Lifted Out.
The forceps here grasp the dura below the end of the cord proper. (Compare with Figs. 158, 159.)

The organs of the thorax and abdomen having been removed, the point of the chisel is introduced close to the centrum of the lower lumbar vertebra, so as to engage the pedicle; then bring the axis nearly to a right angle with that of the spine, and drive it forward, headward; then disarticulate the spine by cutting the intervertebral disk, and by freeing the remaining attachments the whole column of centra will come away. This process is not difficult after a little practice, but is only useful in exceptional cases.

The use of the Brunetti chisels is generally to be avoided, as great damage is apt to result, though in skilful hands they are at times quite satisfactory.

The use of the double-bladed saw is not recommended for the beginner, as there are so many difficulties that must be overcome. In the hands of one skilled in using it the results are excellent, but it requires such care in holding and propelling that it is apt to run away from the inexpert and choke and jam and cause damage. The single blade is quite as much as the average operator can manage. The use of bone-cutting forceps is seldom desirable because the jaws must be large in order to stand the strain, and the risk of injuring the cord is, therefore, great.

In children one can use a small-sized pair with advantage.

At times bone cutters are useful in making special dissections.

At times it is desirable to remove segments of spine with the cord in place, and then to open the canal by carefully directed saw cuts. This is not difficult if the position and slant of the articulations are remembered. (See Figs. 250 and 251.)

During the process of opening the spinal canal the vertebræ will be sufficiently displayed to permit of a fairly thorough observation of their development, condition, and position. Conditions of actual disease are not rare, and one not infrequently finds evidence of violence, and this at times when least suspected. This should not escape the notice of the operator, as in a case where I had to make a postmortem on a body that had been previously cut, and found a crush of the spine that had been entirely overlooked. The spinal canal being laid open, the cord will be found lying in a loose sac. This sac is more or less anchored in place, but permits of considerable motion. The enclosed cord is also loosely fastened. Before touching anything one should note the amount and distribution of blood in the dural vessels and of the spinal fluid inside the dural sac.

After making the examination of the dura *in situ*, it is grasped firmly with a pair of broad saw-edge forceps in the lower lumbar region, and drawn gently upward and headward, while with a sharp knife or scissors it is cut across and then freed from the bony walls. Only gentle traction should be used and no handling allowed.

Where to cut the nerve-roots depends on what further study is to be made of them. If they are to be traced outward with their ganglia, they should be cut close to the dura, but if only the cord is to be considered they had better be cut close to the wall of the canal; but if this requires traction on the cord, then they should be cut in the way to best avoid such traction.

At no time should the cord be sharply bent, compressed, or subjected to considerable force. After the cord and dura have been removed the mass should be most gently treated, and may be laid on a ruled dissecting board or in a shallow dissecting dish filled with normal saline and having a black wax inner bottom. I prefer to orient the cord with the body, that is, if I have removed it through the cut in the back

and the body is still face downward, I place the cord posterior surface upward, parallel and near to the body.

To open the dura, grasp with the forceps on the upper surface, raise it gently, and with a small pair of scissors open it in the midline of the uppermost surface. The two flaps may be pinned out on each side, but only gentle traction is to be used on these flaps, as damage can be done by pulling on the nerve-roots, specially in softened areas of the cord.

The cord may be left in contact with the dura to serve as a support while making further dissection, or to suspend it in fluids for preservation, or while preparing it for slicing, or it may at once be freed.

To examine the cord at once it may be gently passed over the left hand from head end downward, while transverse cuts are made with a section razor.

I prefer the one shown in Fig. 32, cutting away from me and resting the under surface of the blade on the thumb of the left hand. If the cord is still connected with the dura, then sections will be held in their proper order, and by cutting between the nerve-roots each segment can be better studied.

I do not regard the matter of the exact length of the segments as of value unless the measurements of the whole cord and its parts have been very carefully made, as the real, natural division is into nerve-root segments and not into any arbitrary lengths. The careful handling of the nerve-roots is apt to be neglected, which is entirely wrong. They should be treated with extreme care, as degenerations have been simulated by artefacts due to manhandling. Too much stress can hardly be laid on the need of care in handling nervous tissue that is to be studied by means of microscopic methods.

The examination of the cord should always include a study of the condition of the blood-vessels on its surface, and any differences in the various segments is of importance. The surface will generally give some indication of serious lesions within, either by unusual contour or by color changes, or by the blood-vessels, and any asymmetry in any segment is significant. When such conditions are noticed the transverse cuts may be made so as best to display the involved areas, due regard always being had to the requirements of subsequent study.

If lesions are suspected in the upper cervical region, great care should be exercised in the approach through the bones, and it is well to open the occiput so as to get at the medulla and cord together. Too much traction is often exerted while removing the brain, and the low cutting of the cord in the removal of the brain is often undesirable because of the slanting cut almost necessarily made and the traction exerted on the nerve-roots. If the cord and brain are to be removed together, it is well to thoroughly free the cord from the canal before touching the brain, and it can then be slipped through the foramen magnum or lifted out if that is opened.

Lesions of the cord may result from disease outside its envelope, in which case it is necessary to dissect so as best to display both the offend-

ing part and the affected cord. The diseases of the spine itself are apt to cause secondary changes, either by mechanical effects or by direct extension. Violence rarely reaches the cord until it has damaged the spine. A few cases of direct woundings when the instrument or projectile has passed between the bones are met with.

Fig. 158.—The brain exposed by a nearly circular cut, the plane of which passes behind the ears and in front of the vertex. The upper cervical vertebræ and the remains of the occipital bone were carefully chiseled away. The dura was removed at the foramen magnum. The brain and upper cord are still in position. The lower cord has been freed and turned to the left.

In all cases of injury to the spine the dissection must be adapted to display the resulting effects with as little force as possible, because when violence has been done to the spine it is easier to produce secondary injury to the contained cord; thus, in fractures and dislocations of the spine simple handling of the body for inspection of the exterior may

cause severe laceration of the cord that had not existed, and might give rise to serious mistakes.

The study of the cord is a delicate one, and consists of two entirely different processes which must be harmonized from the outset. The macroscopic examination shows so much regarding the circulation, consistency, and texture of the organ that cannot be in any way discovered by sectioning, that I believe even careful students are apt to pay too little attention to it.

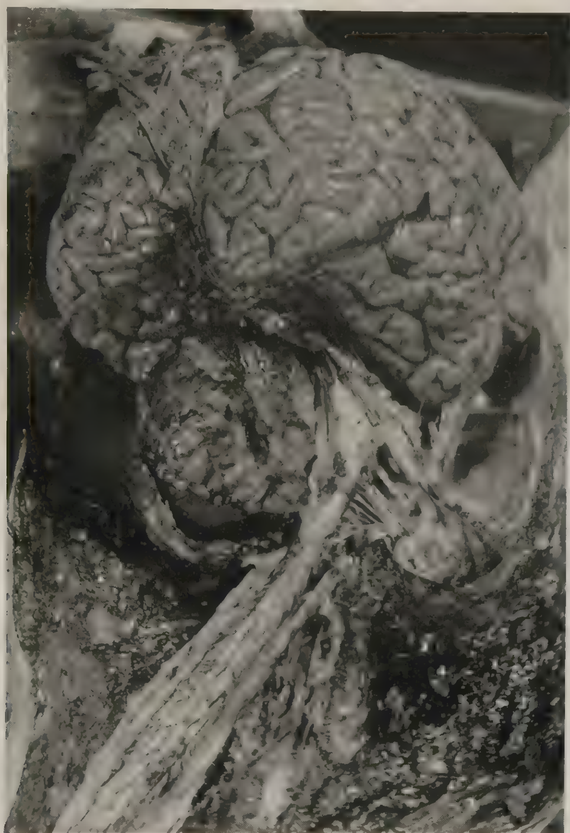

Fig. 159.—The right side of the cerebellum has been removed to show the nerve-roots and the floor of the forth ventricle. The dura of the cord has been opened and the spinal nerve-roots and the surface vessels are seen. (Compare with Figs. 155–158. In Figs. 158 and 159 the brain has become slightly bent to the left by its own weight.)

This is also true regarding the areas of degeneration which are found. The peculiar distribution, color, consistency, and surroundings both in other parts of the cord and in adjacent tissues are generally materially changed by the processes preparatory to section work. Traumatisms of the cord, specially in the earlier stages, show more to the naked-eye observer than they do on sectioning, but the

secondary degenerations of special paths and areas require microscopic study.

Infections of the cord are often difficult to trace. The extension from the brain is at least one of the commoner modes.

Direct infection by organisms in the blood is not rare. Extension from spinal disease may take place, but when we consider the great number of cases of spinal disease where the cord escapes, we conclude that this is a rather rare method. This is undoubtedly due to the protection afforded by the system of membranes.

Extension along the nerves is a rather undeveloped subject at present, but I am convinced that as we progress we will find that ascending neuritis is far more common than is usually supposed.

Fig. 160.—The Brain and Cord Removed Together. (Compare with Fig. 159.) The dura of the cord has been fully opened and is pinned out. The right fissure of Sylvius has been spread open to bring into view the branches of the middle cerebral artery. (The right cerebellum has been removed.)

At times diseases of the blood-vessels play an important part in spinal cord conditions.

Traumatism of the cord is a most important but still a very unsatisfactory subject. Gross lesions can be more or less carefully studied and their extent ascertained, something can be done in the matter of estimating their duration, but concussion, where no gross lesion is found, is often very unsatisfactory

I have seen such cases where an ascending neuritis was the cause of the trouble by continuously exhausting the spinal centers. In other cases obscure inflammations external to the cord have produced marked cord symptoms; by affecting afferent nerves they give signs similar to

cord lesions, and by affecting efferent nerves they produce corresponding sensations and may cause local exhaustion in the cord which, by severity and continuance, give rise to extensive spinal exhaustion, if not degenerative changes, sufficiently marked to be clear to the observer. My belief is that many cases of spine injuries act in one or other of these manners rather than by direct concussion of the cord itself. Carefully considering the surrounding tissues, with thoughtful dissection of adjacent structures, one not rarely finds the trauma has affected the cord only indirectly, even where expert neurologists have diagnosed primary spinal cord lesions.

THE NECK

The neck is a singularly neglected part of the body—neglected, in fact, by nearly everyone, from the very clean young man, who develops boils when the collar grinds in the dirt, to the specialist who fails signally when he tries to tell you about the hyoid bone.

Apart from the upper end of the windpipe and the place to ligate the carotids, the average medical man knows very little. Through this great traffic center pass all the food and air to the body and all nervous impulses to and from the central plant. The blood machinery is anchored in the root of the neck and some extremely important vessels enter its substance. The three great columns of the neck, by their architecture and functioning, are vital to the life of man.

The central bony column has its elaborate capital, the skull, while the posterior or nervous column has the brain as its capital, and the anterior or throat column, containing the great tubular structures, is capped with the elaborate and marvelous speech mechanism.

Two separate and entirely different sorts of muscular groups operate the systems they belong to. The massive, coarse, and powerful skeletal muscles clothe and operate the spine and skull, while the fine, delicate, and facile frontal group actuate the structures of the anterior or throat column.

Nowhere else in the body is there such an interlocking collection of parts with different functions. The arteries and nerves to the hands pass through it, and the glands or chemical regulators are strikingly represented in it. Countless infections gain access to the body through its various channels, and many an unsuspected infection proves serious, if not fatal, that gained its first foothold in its structures. Embryologically, its story is equally remarkable; structurally, it is wonderful; pathologically, it is of prime importance; practically, it is one of the most significant parts of the organism, yet the works on postmortems barely mention it, and the literature is not only inadequate, but frequently grossly misleading.

Fashion dictates abuses that seldom if ever receive the slightest recognition in the medical world. Tight collars that impede the circulation to the eyes, ears, and brain, often with serious impairment of function, receive no condemnation by the specialists in these organs.

Stasis in the muscles and nerves causing forms of serious neuritis is treated only by charlatans, though the lesions are common and painful, if not seriously injuring bodily efficiency. We are taught to scrub our teeth every day, but not one in a hundred takes even decent care of the organs at the top of the throat column. We read that the esophagus is rarely diseased, but I find it constantly sharing in the diseases

of the organs it connects. The pharynx receives endless attention, but the trachea next to none at all. Asthmas centering in the trachea are seldom if ever understood.

Infections that spread from the throat surface to the great vessels and nerves receive only the most general consideration. Medicolegal experts go into court and narrate the most barefaced impossibilities regarding findings at postmortems, and no one seems ready to check the abomination. The thyroid body and its accessory bodies are now just beginning to be studied seriously, but we are only feebly entering the threshold of this vast field of neck chemistry.

Men love to make dissections on the necks of those recently executed, yet the literature is a nightmare of anatomic terms with little if any evidence of knowledge of the architecture of the neck, without which knowledge the problems never can be solved.

At best we find considered each individual piece with painful and thoughtless minuteness, but the actions of the whole interlocking device is passed over in silence.

How the structures are anchored and supported, and how these fixing mechanisms vary and what the variations mean, is as unknown as darkest Africa half a century ago. Why the diaphragm does not pull the trachea is a catch problem that I love to ask, and I have never yet had the answer given. What is the position of the hyoid bone? seems to rival the mystery of the sphynx. Yet it is the most active bone in the body, but nearly all plates of it are in error.

The mere fact that executions have for ages been carried out by operating on the neck shows how generally its importance has been recognized by the non-medical part of the world.

The Roman matrons had a realization of the sympathy of the neck with the sexual functions. Language has many evidences of a realization of its importance among the common people which bears little relation to the astonishing neglect by the medical profession.

The clothing and decoration of the neck are almost universally practised, and those who judge of the physical character of animals as well as those who measure the mental, moral, and physical character of human beings, find in the study of the neck so much of importance that those of us whose duty it is to understand the bodies we take apart would do well to consider far more seriously the "points" shown by the neck. Surely we have often deserved the criticism of falling into the habit of looking at things as we find them without realizing mentally what the things we see signify. From descriptive anatomy's point of view the neck is more complex than interesting. Mechanically, it is second only to the brain in intricacies both of device and adaptation. Physiologically, it is very difficult, but after death the functions have vanished and the difficulties of comprehending it are greatly increased, but if we have a knowledge of its physiology and a purpose of understanding what we see at the postmortem, our troubles are lessened, and this intensely interesting field will become more attractive and better understood.

The neck includes all those structures from the floor of the mouth in front and the skull behind to the upper edge of the first ribs. This lower, or basal plain, is the most important horizontal plain of the body, because from it are suspended the heart and lungs directly, and through the mediastinum the liver. In this plain, or near it, the throat structures are anchored. Through it pass, as through a vital isthmus, tremendously important vessels and nerves. It is not surprising, therefore, that the neck is an index of the vital powers of the body. Its size, shape, and development tell more of the condition of bodily health than any other single part.

It is not enough to remember that such extreme conditions as cretinism, myxedema, and scrofula can be diagnosed by looking at the neck, nor yet the significance of extremes of development, such as the bull-neck or the long, thin neck of debility.

The distribution of fat, fiber, muscles, glands, and vessels in the neck gives us information we cannot afford to ignore if we are looking for those factors which underlie disease; and unusual conditions, such as swellings, congestion, and inflammations or injuries, are of vital import.

The time will come when medicine shall have progressed to a point where the general causes of disease are known, then it will be found desirable to understand why the individuals differ in their relations to disease, and the relations existing between all the peculiarities of individuals will be studied, and there will be a large new science developed which will measure the significance of these peculiarities in relation to disease and health, and preventive medicine will rest largely on this new science, and the study of the neck will take a large part in such work. The significance of the embryology of the structures that constitute the neck, and that have developed from primal neck structures, will be regarded in an entirely new way, and the unity which persists in ground plan, after extensive development has masked the origin, will be appreciated. The origin of the lungs and thymus below, and the jaws, ears, and salivary glands above from the primal neck, with its gill-slits and arches, will not be forgotten when we discuss normal and abnormal variations that underlie conditions we are trying to explain.

Our present problem, which is to study and take the neck apart so that we will gain the best possible understanding of the conditions presented, must rest on a large comprehension of all these things.

EXTERNAL EXAMINATION

We note not simply the size and shape, but the development, of each constituent part and its condition.

The skin, its texture, thickness, and the way it is drawn over the parts, and whether it is capable of covering a greater amount of contents, also if it is freely movable on the underlying tissues. The general condition of the fibrous and fat elements is studied to see whether it agrees with the law of harmony of distribution of these factors, the

flexibility of the spine, and the quality of the muscles of both the masses at the back and the finer ones in front.

The cartilages associated with the air-passages, the development of the normal, and the presence and development of pathologic gland structure. The evidences of former or present disease, such as boil scars, are not to be overlooked, as they often throw light on infection and resistance.

Boils and carbuncles so often begin in the neck, and their sequelæ continue often throughout life, that it is more than desirable to properly consider all evidence we find of them.

DISSECTION

Generally it is undesirable to make extensive cuts in the skin of the neck owing to the resulting disfigurement. Where no such limitation is necessary, the cut will begin at the chin, and the skin will be dissected away from the cut and retracted fully to allow full view and easy dissection. Ordinarily it will be necessary to limit the cut to a point which will be covered by the neck dress. This gives a perfectly good view, but impedes the dissection. My habit is to cut from above downward from a selected point, usually about one-third of the distance from the sternal notch to the chin, then dissect free the skin well up and out, retract the skin, with twine, forcibly upward (as in Fig. 161) and to the sides if necessary. The superficial veins, after careful observation, may be ligated and cut or clamped or twisted. The dissection had better be done one side at a time, at least in part.

I prefer to dissect the muscles in layers, removing the outer layer from below, cutting at the sternum, and reflecting. The thyroid group of muscles can be then removed entire or, better, laid off in flaps by layers, either to the side or from above the thyroid depending on the needs of the case.

The habit of cutting the floor of the mouth from the lower jaw is excusable only when it is necessary to save time, and is generally bad practice. The rule should be to remove the muscles and so-called indifferent tissues in layers, which can be replaced. At times it is proper to take out the whole throat mass in order to reach the pharynx, tongue, hyoid bone, or larynx quickly, but such is to be regarded as a special procedure.

The superficial nerves and vessels will be noted as they pass through the layers removed. To save these and their relations it may be desirable to dissect the flaps in such a direction as to go from their tips toward their sources. The thyroid body and its relations will be observed and, if desirable, investigated. It may then be reflected as a flap or removed or opened in the midline and one side reflected outward. The deep vessels and nerves can easily be pushed to one side or retracted while the trachea and larynx are studied, or they may be removed on one side, and the trachea and esophagus removed.

The medicolegal examination of the neck frequently involves special

care in studying the condition of the muscles, vessels, and cartilages; in such cases evidence must not be destroyed by thoughtless routine practices.

In such cases the position of the parts must be considered with special care with regard to postmortem changes, both of posture and of rigidity of muscles, and the mobility of parts must not be thoughtlessly misinterpreted.

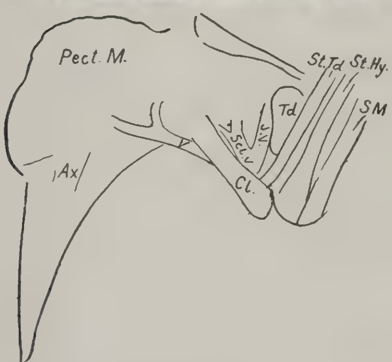

Fig. 161a.

Fig. 161.—Neck and Axilla. No. 1.

Ax. Axilla. *Cl.* Clavicle. *Pect.M.* Pectoral muscle, reflected. *S.M.* Left sternocleidomastoid. *St.Hy.* Left sternohyoid muscle. *St.Td.* Right sternothyroid muscle. *Td.* Thyroid. *J.V.* Jugular vein. *Scl.V.* Subclavian and external jugular vein. *V.* Subclavian and axillary vein.

By cutting 2 inches above the suprasternal notch, freeing the skin, and strongly retracting by strings, this whole important area is laid bare. The muscles are carefully detached from their lower and inner attachments and reflected layer by layer, so that any violence is clearly seen and its extent and degree made clear. The end of the clavicle has been detached to show sort of cut needed to free its end. The diagram is reduced from a tracing.

Nowhere in the body is the problem of elasticity more important than in the structures of the neck. The position of the parts will depend on their elasticity in no small degree.

The size of an artery must always be considered with its elasticity, for an inelastic one must be much larger, to allow a given volume of

blood free passage, than a highly elastic one. I have seen many startling errors made through ignoring this simple and obvious fact. The attachments of the parts—above to the jaw, below to the ribs, sternum, and clavicles, and behind to the spine—are not simply looked at, but their tensile strength and elasticity, as well as their distribution, must be tested by actual force applied before the neck can be understood.

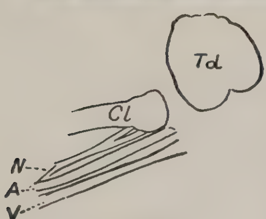

Fig. 162a.

Fig. 162.—Neck and Axilla. No. 2.

Td. Thyroid. *Cl.* Clavicle. *N.* Nerve. *A.* Artery. *V.* Vein.

By cutting close to the bone the clavicle has been freed and it is retracted. The vein is under considerable tension as it turns over the first rib. The artery is seen raised on the forceps and is seen dipping into the tissues of the neck above the vein. Several strands of the nerve are seen pointing upward. The anterior muscles have been reflected upward leaving the thyroid body exposed. The sternum has been cut away and the lungs show almost no retraction and meet in front. (Compare with Figs. 161, 163, 164.)

Every part of the neck has its tensile strength, and each contributes something to the position of the whole and its parts, the whole mass constituting as it does a column whose shape and position depends on the resultant of all these different pulls.

The functions of speech, swallowing, and breathing depend directly on these, but the condition of the organs supplied by the vessels and nerves that pass through the neck depends indirectly on the habitual and accidental massage received by the action of these various structures—muscular and elastic.

The question why the thyroid is located where it is rather than in some other place can only be answered by first realizing what happens

to it where it is that would not happen elsewhere. By holding the finger over this body and swallowing, and bending the head freely, one realizes somewhat of the significance of the position of glandular organs. It is desirable, therefore, to resort to a number of methods of mechanically studying the organs of the neck if one would rise above the dead level of descriptive anatomy.

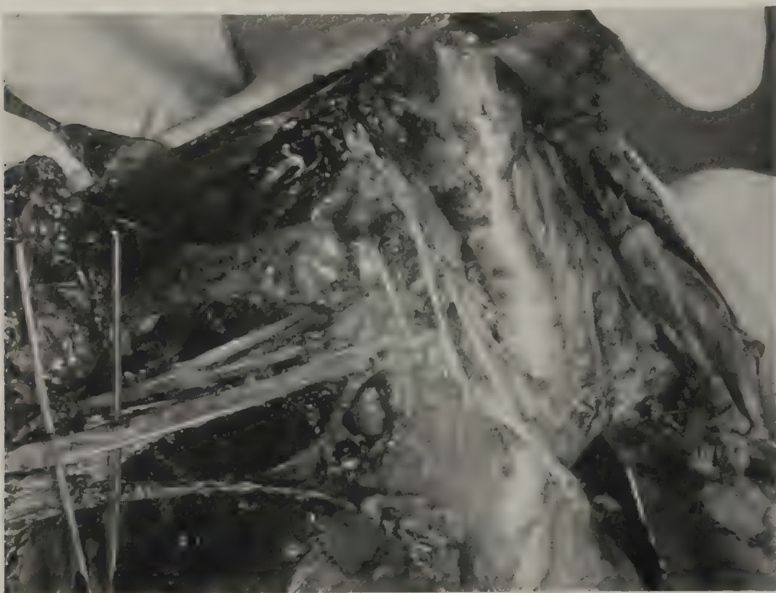

Fig. 163.—Neck and Axilla. No. 3.

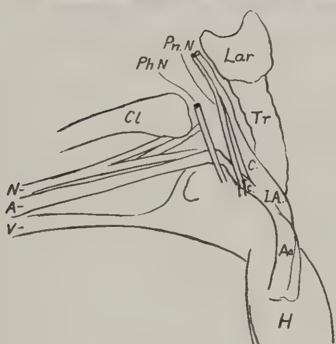

Fig. 163*a*.

A. Axillary artery. *Ao*. Aorta. *C*. Carotid artery. (*S*)c. Subclavian artery. *Cl*. Clavicle *H*. Heart. *I.A*. Innominate artery. *Lar*. Larynx. *N*. Cords of brachial plexus. *Ph.N*. Phrenic nerve. *Pn.N*. Pneumogastric nerve. *Tr*. Trachea. *V*. Axillary vein.

The thyroid body has been removed and the tissues and muscles of the larynx brought into view, as well as the vessels and nerves of the neck. The lungs have been removed to uncover the heart. The pericardium is laid over the cut edge of the ribs. The tissues are under tension because a block raises the thorax so that the head and right arm are dependent. It will be remembered that no extra skin cuts have been made in this whole series.

The approach to the larynx is naturally from above and behind because its opening is best seen from that direction, but a careful cutting in front is often of advantage in approaching certain special conditions. This is specially true where the manipulation necessary to remove it from its attachments may produce changes in its condition or contents. In medicolegal cases this often occurs.

One may properly at times save energy and time by opening the trachea from below upward and extend the cut through the larynx. This procedure is apt to damage the epiglottis unless care is taken, but it gives a valuable view of the structures which adduct the cartilages. The esophagus may be opened at any part or in any direction, provided always that its relations have been observed and its conditions are not

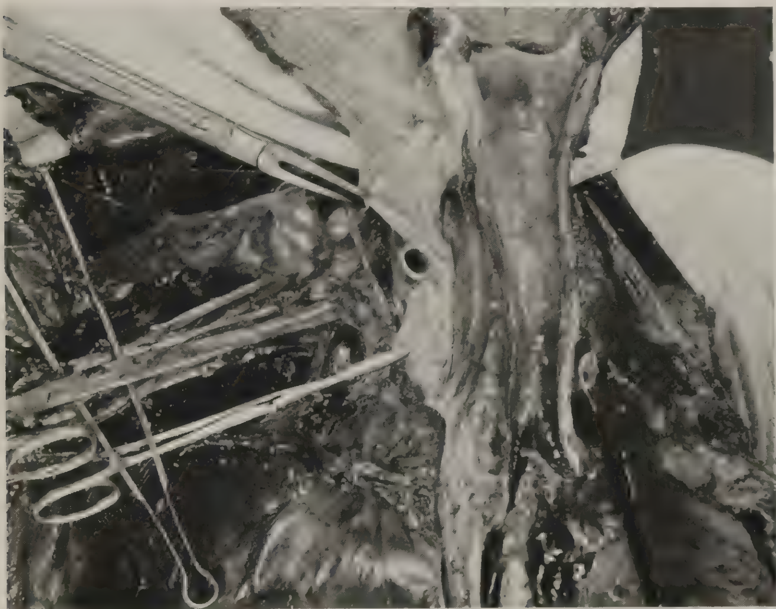

FIG. 164.—NECK AND AXILLA. No. 4.

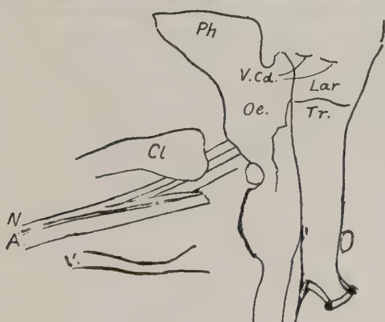

FIG. 164*a*.

A. Artery. *Cl*. Clavicle *Lar* Larynx. *N*. Nerve. *Oe*. Esophagus. *Ph*. Pharynx. *Tr*. Trachea. *V*. Vein. *V.Cd*. Vocal cords.

The larynx and pharynx have been removed from their attachments and separated. The trachea and larynx have been opened from the back and show congestion. The bronchi below are markedly congested. The esophagus and pharynx were opened from the side and show small congested patches. The trachea has shortened somewhat by natural elasticity. The cut end of the innominate artery is drawn slightly upward.

thoughtlessly changed by the procedure. The glands should be studied where found, not simply in regard to number, size, and condition, but specially with regard to their distribution with relation to the parts, and with the purpose of reading from their condition the history of the parts affected, from which they became changed.

The **hyoid bone** is of importance from a medicolegal as well as a

physiologic point of view, and its position and condition may need special study. Its position at the top of the throat column causes it to change its relative location and posture with every bending of the head, so that the pictures given in anatomic works are very misleading because of postmortem changes in the subjects from which drawings were made. Its condition as to union of the body and horns and the elasticity and motion of the parts varies as well as its freedom of motion. One bone will bend freely, so that the tips of the great wings may be brought together, while another will snap; still another will give way at one of the joints. No general rules will apply to it, but it must be studied in all its relations and qualities in the individual case.

Changes in the neck, specially swellings, edemas, congestions, and inflammation of the tissues, are far more common than one would suppose from the literature and protocols of postmortems. Trachitis is very common and esophagitis is far from rare, as we are told in the text-books. Extension from one tissue to another is of great importance, and too little studied in the neck, where inflammation of the different structures is common and generally overlooked at the postmortem.

Infections frequently creep along the paths of least resistance or by continuity of culture-medium, and involve the vessels and nerves oftener than either clinician or pathologist suspect, and anginas following local inflammation of the mucous membrane are often the basis of serious conditions which at present form part of many mysterious and unsolved problems. Specially is this true in the spasmodic forms associated with asthmas and coughs, but equally true with regard to the more obscure esophageal catarrhs.

These esophageal catarrhs are modified to a degree by reason of the regurgitation of acid from the stomach, and are less apt to spread because of the resistant nature of the walls, and are overlooked because the color has faded, as it does in many tissues after death, and because frequent swallowing removes the discharges of mucus to a large degree. A review of the literature on the esophagus and a large experience will show how generally, if not wholly, this large field has been neglected.

THORAX

The thorax as a whole mechanism presents many interesting and important problems. Those who have mastered the principles of physi-

Fig. 165.—This picture clearly shows a number of interesting peculiarities: Lungs, fully collapsed; pericardium large, thick, and fully distended by a large powerful heart which is almost pericardium bound. Note particularly the junction with the diaphragm. There is general fibrosis of all supporting structures, but not of the pleura. The diaphragm is extremely powerful and shows a cleanly rounded dome. The omentum is small. The gut is thick walled and of a very powerful type, with some injection, specially in the lower part. The liver has a sharp, clean-cut edge, and is well supported by its ligaments, specially the mediastinum. This is one of the most striking cases of organic power in the viscera I have ever seen.

FIG. 166.—THORAX SERIES. No. 1.

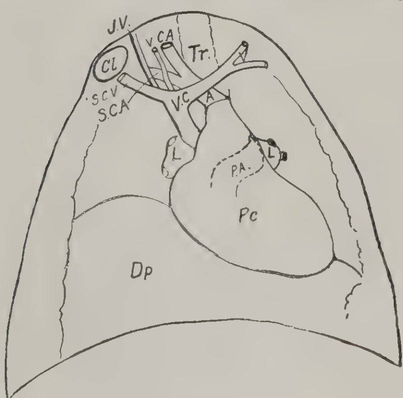

FIG. 166*a*.

Body of fat man in horizontal position. The diaphragm (*Dp.*) is crowded up by the abdominal viscera. The pericardium (*Pc.*)is rounded by posture. The aorta (*A.*) and the arteries (carotid, *C.A.*, and subclavian, *S.C.A.*) and the veins (*V.V.C.* and *S.C.V.*) are all relaxed and more or less transverse. The lungs have been cut away, leaving only the stumps (*L.L.*). The clavicle (*Cl.*) is but slightly displaced outward. (Compare with the other photographs of the series, specially Fig. 167.)

Fig. 167.—Thorax Series. No. 2.

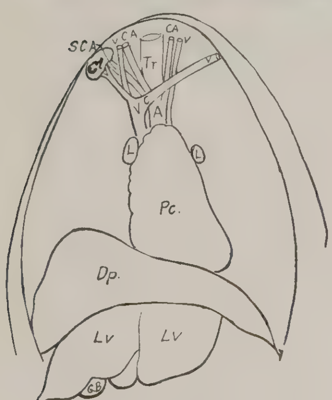

Fig. 167*a*.

The body has been raised from the horizontal position so that it is now at about 45 degrees. The abdominal viscera have settled freely and they exert traction on the diaphragm and its support, the mediastinum. Note the entirely different picture presented by the heart and great vessels. This has been produced simply by the gravity of the organs. Compare the angles made by the great vessels with the string which is stretched above the clavicles.

cal training find a never-ending series of interesting and profitable observations in the chest. These problems relate largely to the perfection of the various mechanisms for their special work and the influence on the general health of their variations.

The observer at the postmortem has many added considerations of disease, both of cause and effect, to study. The student who has become a slave to laboratory wisdom is apt to lose sight of the broad problems of life and health, and to have his mind narrowed to diseases and "exact" signs, and the chief culture he is interested in is of microörganisms. The significance of the air supply to the body is far from being a solved problem either in health or disease.

The chest has been elaborated in the vertebrated animals, at great cost and effort, to give adequate air supply. This mechanism is not infrequently so changed beyond the limits of normal variation that the condition amounts to an actual disease.

Rigidity of the chest walls may result from disease in the parts, or it may give rise to such ill health as to be properly regarded as the true cause of it.

Associated with the function of respiration has been developed throughout the whole animal kingdom the circulatory apparatus, and the many devices that have been adopted or, as we now say, selected under evolution to perfect the efficiency of these two systems have become one marvelous apparatus of interlocking mechanisms.

The thorax is a bellows to fill and empty the lungs, for the supplying of oxygen, and the removal of the waste products, but the name itself carries a large thought, that of protection, protection of vital importance in the struggle for life, and this conception formerly received better recognition than now is granted to it. I am so often impressed by another function that I have decided to include a few illustrations and some explanation of it. This is the further import of the architecture of the thorax in relation to the support in position which its contained structures derive by reason of their position and attachments.

ARCHITECTURE

The fixed ring formed of the uppermost ribs forms the true base of the thorax; here it coincides with the neck base. The massive vertebræ having limited motility form the stem to which its structures are ultimately attached. The semimobile upper ribs contrast clearly with the mobile lower ribs; the difference is at least partly grasped by enlightened students of the distribution of tubercular lesions. The significance of the stiff sternal plate with the underlying cardiac mass is seldom grasped. The muscular pyramid above in the neck, with attachments to the common base of the neck and thorax, is anatomically a part of the neck, but physiologically part of the thorax.

The thoracic parts of the spinal cord, esophagus, and spine-moving muscles are generally studied separately and apart from the special thoracic organs, yet each of these is most intimately built in with its

neighbors, as anyone with an attack of "intercostal neuralgia" or esophagitis or stasis of the spine will not fail to observe. The reason why the thoracic duct goes through the thorax instead of taking a short cut is proper food for thought.

THE MEDIASTINUM

The mediastinum is described as "the space left in the median portion of the chest by the non-approximation of the two pleura." One might as justly describe the lung as that space enclosed in the sac of pleura on either side. This mass of structures is vitally associated with the intensely active and immensely important organs of the thorax, and every part of it is constantly acting with these organs. It is the great central ligament of the diaphragm and, through that, of the liver. It anchors the heart and great vessels so that each may perform its functions.

To try to conceive of the heart acting in the human being apart from its elaborate supports is as silly as separating a gun from its mounting. The attachment of the lungs to the spine and to the thoracic base is a wonderful piece of mechanism. The interaction of these organs, directly and through the medium of the mediastinal tissues, is only occasionally looked into where some disease process forces it on our attention, and then, by reason of our former neglect of the problem, we become foolish in vain endeavors to explain what we find. Not only must we reckon with gross lesions amounting to a pathologic specimen, but we must measure the significance of variations of structure, of size, of texture, of elasticity, of attachment, of mechanical efficiency, and interference of these parts.

DIAPHRAGM

Strange as it may seem, men have been hung because ignorant experts reasoned falsely about the height of the diaphragm, and hundreds of deaths have occurred following operations on the belly because operators ignored the intimate relation of the heart and diaphragm, and failed to realize the effect of a tight bandage about the belly, with a horizontal position, on an already overtaxed heart.

If we will but understand the thorax and its relations in the limits of normal variation and change from infancy to old age, our problems, when we find pathologic conditions, will be vastly simplified, and we will be less frequently driven to use the stock phrases and platitudes of the postmortem room, the clinic, and the laboratory. The thoracic structures are remarkably mobile in infants, and a good pull on the diaphragm will move the trachea or even the tongue; while in adults such motion is restricted; in old age there may be increased rigidity or a partial return to mobility. Early rigidity, however, is clearly detrimental, and usually precludes the possibility of old age. There is no health possible where the normal massage of the parts has been seriously interfered with, and this is particularly true in the thorax and its neighbor, the abdomen.

Fig. 168.—Thorax Series. No. 3.

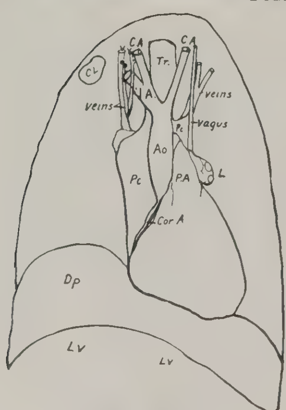

Fig. 168*a*.

The pericardium (*Pc.*) has been reflected and shows its extension on to the great vessels. The tension on these vessels is well shown. The coronary artery (*Cor.A.*) is raised on the hook.

The diaphragm is drawn and described as found in the dissecting room, and only recently has its action and position in life been studied by means of the x-ray. The result of this x-ray work has already begun to be recognized and our conceptions are enlarging. As an object to be viewed in the place in which it is found after death, without going further (and this is on a par with a similar study of the vocal cords), it is of very little importance. It must be investigated, its excursion tested, with a careful observation of the effect of this excursion on the pericardium and its contained organs; on the liver and its relation to the

Fig. 169.—Thorax Series. No. 4.

The right ventricle has been opened to show both valves. The auriculoventricular is retracted. Two of the pulmonary leaflets are seen above.

Fig. 170.—Thorax Series. No. 5.

The right auricle and vena cavæ opened to show their entire thoracic relations. With Figs. 168 and 169 shows how the heart is investigated in the thorax without being removed.

bile apparatus; on the pancreas and its vessels and ducts; on the whole contents, in fact, of both thorax and abdomen. Then we will have a basis on which to begin to understand such problems as why surgeons find that hearts do not give out so often if the posture of persons operated on are adjusted so as to relieve the overdistention upward of the diaphragm. It is not enough to wait until we have a case of tracheal tugging in an aneurysm before we study the strains and adjustments within the mediastinum. The relation between size and shape of the thoracic cavity must be clearly grasped and the postmortem changes

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due to posture reckoned with before measurement of the height of the diaphragm will signify anything. The greatest variation is possible in this structure in a number of directions.

The muscular elements may be well or poorly developed or may vary in distribution. Such development is of interest by itself, but is

FIG. 171.—THORAX SERIES. No. 6.

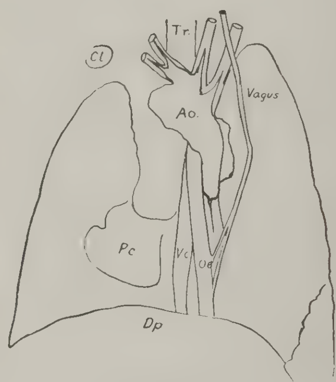


FIG. 171*a*.

Showing the great arteries opened after removal of the heart. The vagus nerve is drawn to one side. Note the intense congestion of the interior of the arteries, which were highly inflamed. The relations of the esophagus (*Oe.*) are well shown.

of importance only when taken in connection with the amount and nature of work to be done. Compensatory hypertrophy of the diaphragm I have seen very clearly marked and atrophy by disease no less sharply defined.

Friable muscle one not infrequently finds, and I am compelled to believe the condition of the muscle of the diaphragm should be more carefully observed with relation to its tensile strength; this is done not by cutting it, but by tearing it. It is not difficult to demonstrate rigor in a diaphragm and it is not usually difficult to overcome this. Whether

this condition is due to the great heat it is subjected to is an open question. Certain it is, however, one often finds the rigor overcome and the diaphragm greatly displaced after death.

The normal lung contracts by its elasticity, causing a positive pull on the diaphragm which lasts usually much longer than rigor, and oper-

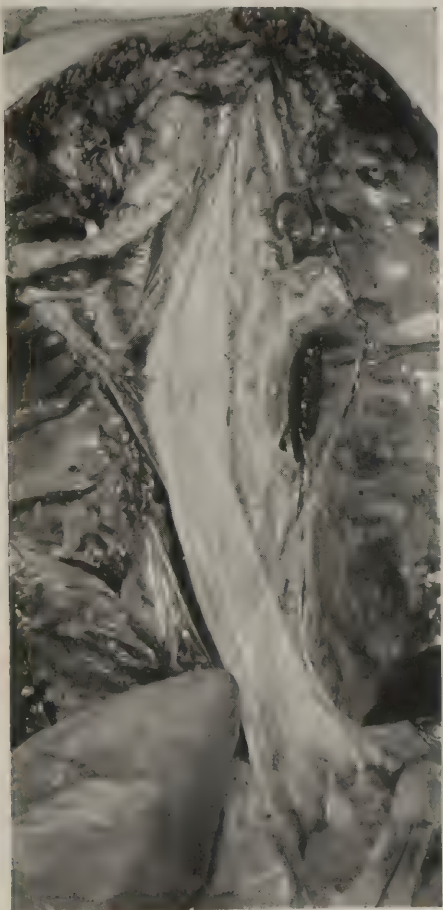


FIG. 172.—THORAX SERIES. No. 7.

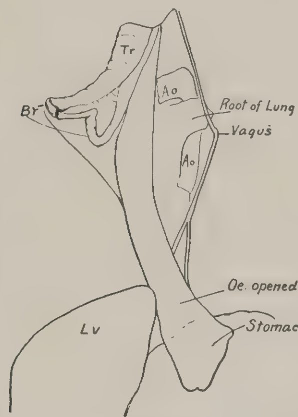


FIG. 172*a*.

The arteries have been reflected. The left lobe of the liver (*Lv.*) turned up and to the right. The trachea (*Tr.*) and bronchi (*Br.*) opened and show congestion. The esophagus (*Oe.*) is opened and spread out. Note the tension, folding, color, and surface. Note also the line of separation where it joins the stomach.

ates, unless impeded by edema, congestion, disease, or senile change, long before rigor usually appears.

The abdominal viscera by their bulk and weight tend to force the diaphragm upward as soon as the body is placed in a horizontal position.

The relaxation of the belly wall seldom gives great relief to the intra-abdominal tension, and at times, as in severe peritoneal irritation, the belly wall may become very tense, thereby greatly increasing the pressure on the diaphragm.

It is clearly absurd to consider the position of the right and left dome

of the diaphragm without carefully noting all the factors which tend to modify its position, and to do this one must grasp the resultant of pressures above and below, and if one cares to, for any special reason, rely on this position as a basis for conclusions, one must consider most carefully the actual condition which existed in the muscular and fibrous component parts of the organ, and judge truly of the effects of postmortem changes both within and on either side, that is, above and below.

Further, one must grasp clearly the significance of the size, shape, and condition of the thorax as a factor in the process of respiration as a whole before concluding as to the conditions under which the diaphragm worked.

It is clear that a big, hard liver will impede the excursion and modify the shape of the diaphragm in life, and that after death the liver may have its front edge tipped up so as to entirely change the height and shape of the dome projecting into the right side of the thorax.

The height of the domes in full relaxation after death has been grossly misinterpreted in so many cases, and the discussion of the subject is so entirely incomplete, that I must warn those who are called on to make statements in court to use far greater caution than has been customary in the past. When we find that diseases or adhesions have affected this structure our problem becomes still more complicated, and I strongly advocate the dynamic method of investigating it; that is, I test the actual influence of these new factors by moving the diaphragm so as to see how much of a push or pull is exerted on it by such adhesions or growths. Indirect study of this organ is valuable. Thus, purging of foam or fluid from the nose or mouth tells me the diaphragm is being acted on mechanically unless some unusual influence is working in the chest wall.

Cutting the peritoneum in the primary incision tells me something of the intra-abdominal tension; pinching a bit of muscle in the belly wall gives me something by which to judge the tensile strength of the diaphragm; percussing the chest, either with the fingers or with the back of the knife, tells me something of the condition of the thoracic organs that can be gotten in no other way. On the other hand, the study of the diaphragm is of great value in laying a foundation for the proper understanding of the other organs.

No one can possibly comprehend the circulation of the blood who has not gained an insight into the action of the respiratory oscillation of the diaphragm on the heart and great vessels. Fully as important are its relations with the organs below. I frequently have asked pathologists and students what relation existed between the rectum and the diaphragm. The answers were generally that there was no relation whatever, until I asked whether they had not used the diaphragm rather habitually to help to empty the rectum throughout life. In such cases it, of course, acts with the other abdominal muscles.

The relations between liver stasis, portal stasis, constipation, rectal condition and the diaphragm are problems that ought to receive the attention of every man who pretends to make postmortems.

Paralysis of the diaphragm is probably rare; respiratory failure is

rather common. Perhaps we are not as careful as we should be in such cases to observe the condition of the muscles of respiration.

Atony and atrophy of the muscles of the diaphragm are much commoner than a careful study of many postmortem records would lead one to believe.

Habit of breathing, clothing, condition of the belly, and whole respiratory apparatus, all influence this muscular organ. Secondary diseases of the organ due to inflammation or tumor of adjacent organs have received ample treatment in the pathologic text-books, but the effects of these conditions on the muscular tissue have not received adequate consideration.

Studies of the muscle of the heart are very generally made, but seldom of the diaphragm, and while it is perfectly evident why heart muscle should be so studied, it is far from clear why the diaphragm muscle should be ignored. Specially is this surprising when we consider how continuously and rhythmically its action is maintained, and how its work varies, and how it must and does undergo fatigue and exhaustion, particularly in such unfavorable conditions as fevers.

THE HEART

The heart impresses the clinician by its marvelous activity and by its response to conditions. Both of these qualities are lost sight of by

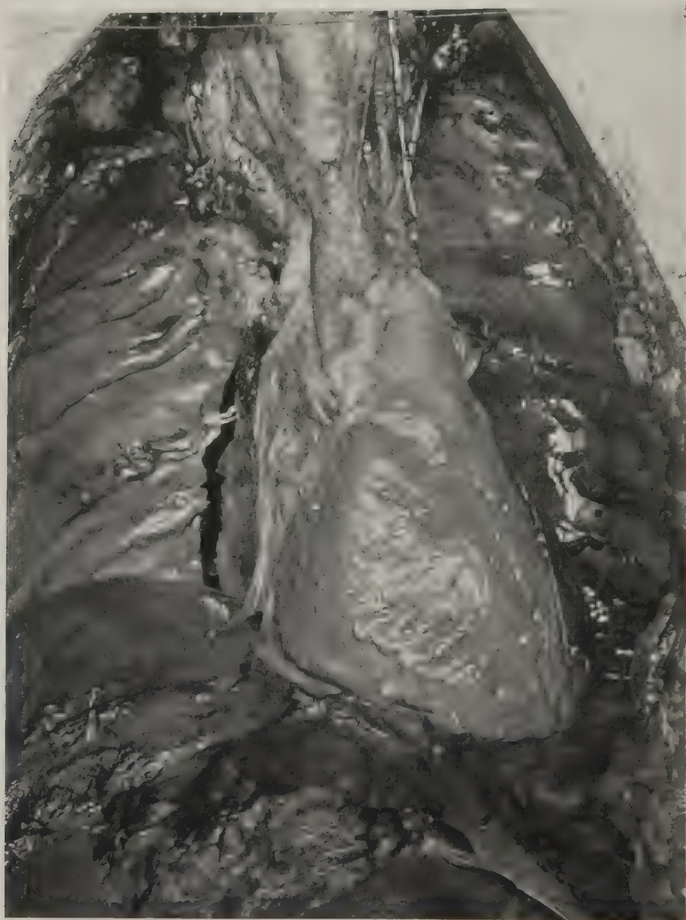


Fig. 173.—The Heart in Position.

The head end of the body was slightly raised to allow the diaphragm to assume a natural position, the pericardium has been trimmed away, and the ascending and transverse aorta, with the carotids, cleared. The line of the pulmonary artery is indicated. The string crossing the picture is projected at a level 1 inch above the top of the clavicles. The great veins are less distinctly seen and the left vagus stands out clearly. The epicardial pericardium is thick, but this is in strict harmony with the pleura and other serous coats in the body.

the pathologist; this is natural, but unfortunate, and should be well considered. The supports of the heart are very important to its right

action, and its posture as a result of the condition of these supports, both from above and from below, is of vital interest. A prize-fighter who had the muscles of Hercules and the wind of an opera singer would be worthless if he could not use his legs properly to maintain position. So a heart that is strong cannot use its force if it is crowded up by a displaced diaphragm, or if its pericardium is tight or misshapen. The heart must be observed as it hangs in the mediastinum, and if necessary the body may be tilted as in Fig. 167 to demonstrate its conditioning with regard to the posture it must or may take, and the direction the great vessels take under the conditions possible in the particular case.

Figs. 166–173 show a case of heart failure in which the belly was stuffed with fat, the thoracic space being greatly reduced thereby, and the heart carried this extra burden badly. The mere settling of the abdominal contents by raising the body to about 45 degrees shows the effect on the great vessels and on the position of the heart.

THE PERICARDIUM

The pericardium is subject to many changes, some of which are within the range of normal variability, while others are distinctly abnormal. The question of importance is not so much what the change is, though that is clearly to be grasped, but What is the effect on the heart itself?

Whatever there is, is to be noted, whether it be thickening, exudate, inflammation, or morbid growth, but the essential thing will be to determine what that particular lesion of the given degree and probable duration did to the particular heart in its active state and in its cycle of activity and relaxation, acting in the surroundings and under the conditions—chemical, physical, and vital—in which it was placed. A drop of pus is of more importance in one case than a pint in another; an adhesion band a few lines wide may stop one heart, while a completely adherent pericardium may simply cause hypertrophy in another.

A relatively large pericardium may mean a tendency to dilatation or simply that a dose of strychnin has caused arrest in systole. A small pericardium may prevent dilatation, though the heart muscle is as soft as wet paper.

In the matter of estimating the size one must always take into consideration the elasticity of the pericardium itself and the size of the vessels enclosed in it, as well as the chambers and substance of the heart.

Large expansile vessels associated with a high attachment of the pericardium will surely have an effect in filling the available pericardial space, and this is seen at times when the space is already encroached upon from without, as in lung and liver disorders. These and similar conditions are often the determining factors in unexpected deaths, and the failure to discover them deprives the clinician of most valuable light on the case, and leads to the failure to understand the vast variability known to exist in the symptoms and signs of well-known diseases.

The text-books of anatomy and pathology do not even suggest the many important problems involved in this so-called simple sac. It will easily be seen that a study of just these problems of heart handicap with the clinical charts and history before one will clear up many of the otherwise mysterious heart deaths one has to examine.

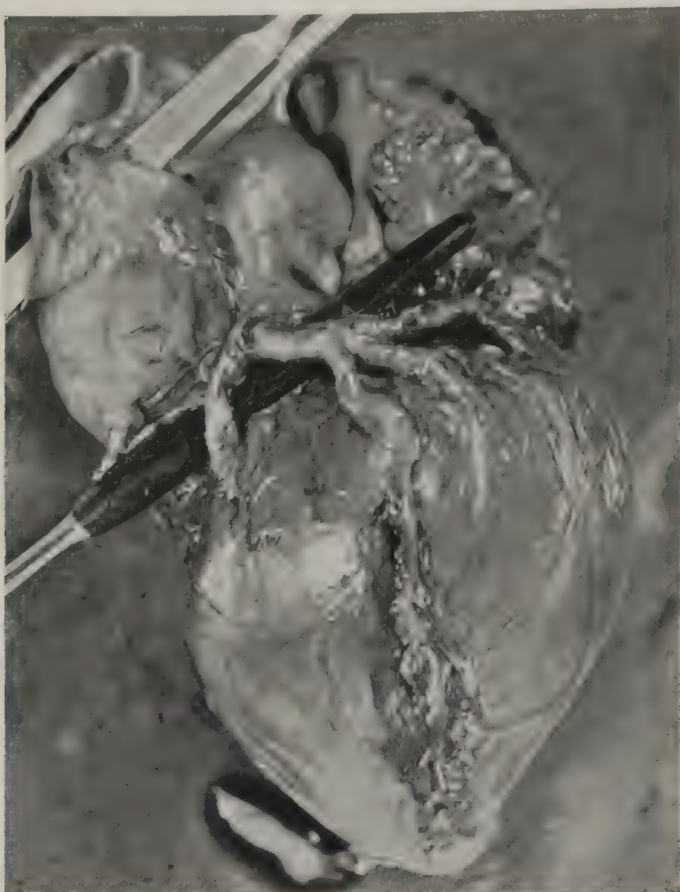


FIG. 174.—The coronary and its branches of one side have been brought into view. It will be noted that the first part is greatly dilated as well as highly atypical, while the more distant branches are not oversized, though thickened. The heart was small, but the aorta was large and its wall thick. (Compare with Fig. 175, where the cause of the condition may be reasonably deduced, and with Figs. 153 and 154, where the results are clearly seen. This group of pictures gives an example of how the organs depend on each other.)

Normally, there is a considerable margin between the heart in full diastole and the pericardium. When this margin is greatly reduced we generally find true dilatation of one or both sides of the heart; if of only one side, we estimate that dilatation as proportionately great.

In normal hypertrophy it is occasionally found that the heart is pericardium bound, and in pathologic hypertrophy this is more common.

Where some part of the heart has ruptured we find usually a very considerable amount of clot enclosing the heart nearly concentrically. This clot, taken with the serum, is usually greater than the capacity of either the auricles or ventricles, and represents their cavities plus the

FIG. 175.—The right kidney is pitted, granular, small, firm, and of high color, with increased capsule. The liver is small, firm, rough. The small intestine is thick walled, congested, mottled, and shows the type of chronic catarrhal enteritis of long standing, with serious chemical results affecting all the organs.

margin or space between the heart and pericardium plus whatever distention was possible of the pericardium by the total available blood-pressure. In such cases the pericardium bulges, shortens, and becomes rounded.

Some of the serum escapes back into the heart through the opening

of the rupture after death, so that the pressure and quantity of contents is always less after death than before. Distention in pericarditis is usually less than in rupture, and there is more time for its dilatation, as well as a tendency of the wall to weaken in the early stages of inflammation and contract in the later stages of reaction.

All membranes are to be tested after the manner of experts in textiles—that is, they are to be pulled along the axes of their component strands and at various angles.

This is supplemented by forcibly pressing a finger against a fairly tense sheet of the membrane and noting the resistance as well as the tendency to recover after the finger pressure has been removed. Like all membranes covered with serous membrane, it is subject to certain congestions. These vary from a simple injection of vessels to a diffuse blush, and much of the color may be lost after death, specially if due to active congestion with little stasis; that is, if the vessels retain their tone and normally contract after the blood-pressure is lowered. Only when the local vessels have lost their tone or when pressure is maintained will the blood remain as in life. Much that was said about lividity, as found in the skin, and about the color of the mucous membranes applies, but the differences in vasomotor mechanism must be remembered in making such comparisons. The texture variations of this membrane must be studied to be understood not simply alone, but with all the other tissues of the body, more specially with the fasciæ and other membranes.

The facts that the pericardium is part of the diaphragm below, of the pleura at the sides, and is united with the mediastinum in front and behind, and that we speak of the pericardium more or less incorrectly, as if it were solely a serous covering rather than as a structure, should not be forgotten. The structure should not be confused with its lining layer.

Inflammations are frequently found to have traveled from adjacent structures, and occasionally appear spontaneously, probably by deposit from a blood infection or pyemia. Such inflammations are serious in proportion as they impede the heart in any way. That surprisingly severe conditions have been recovered from we know from the postmortem findings and from clinical observations.

Perhaps the greatest harm is done by impeding the normal motion of the heart in one or more ways, as by actual compression, by exudate, or by adhesions. The direct effect of the inflammation is more or less obscure, but appears to be of less importance than the indirect. Very rarely have I found rupture in cases of old pericarditis. When, however, the inflammation extends to the underlying vessels or muscles, then the effect is more serious.

The average maker of postmortems nowhere shows less insight than in his labors to describe a heart.

It is common to read long lists of measurements of the heart valves and walls and vessels, and to find extended tests of the competence of the valves by various hydrostatic methods. No doubt these things

have a value in their place, but when we make a postmortem we have an opportunity to search out the larger field of heart labor factors; the condition of the vessels to and from the heart with relation to size, shape, condition of elasticity, obstructions by bending, or by pressure of tissues or organs or tissue changes, all of which show us something of the factors of the extensive work to be done by that organ. The size and shape and condition of the pericardium and the position of the diaphragm, the action of the diaphragm in massaging the heart, both in systole and diastole, by pressure, and by allowing it to hang freely in the sac, or by resisting its peculiar twisting beat; the respiratory cycle as a factor in the suction on venous blood, and this with the intrathoracic pressure as factors in the propulsion; the effect of intrathoracic influences as differing in the two sides and in each cavity, these are all problems that lie open before us in the chest, and are quite as important in the average case and often of vastly more significance than minute studies of valves, and are often of etiologic import, while the condition of the muscle is generally simply a result, the cause lying elsewhere. It is a pleasing fad at present to couple up the heart and kidneys in a cycle. This also is good and proper at times, but I find the gastro-intestinal system is the real cause for the chemical condition underneath both organs in a great many cases.

Diseases of the internal glands and all infections are known to affect the heart. No study of the heart is complete or even reasonably so unless one has studied the organs that may affect the heart and its action.

It is not enough to hack the heart out of the body, open it by some elaborate method, and describe the findings; nor is this properly supplemented by similarly treating all the other organs.

The heart is related to the organs and tissues, and it must be studied *in situ* and its relations thought over carefully.

Let the postmortem be done with brains rather than with instruments and fixed rules alone.

BLOOD-PRESSURE

It matters not how well one may have mastered the mechanics of the circulation, there will still remain new and valuable data to be obtained from every postmortem, provided one remembers what one knows of this part of physiology, while one works.

As the source of blood-pressure, the heart must be considered by using a different compartment of the brain from that containing data regarding brown atrophy, cloudy swelling, lymphoid infiltration, and other similar concepts.

As the mainspring of the circulation its potential qualities must be estimated, and this is a very different matter from simply observing the few details which constitute the usual routine work of a classic postmortem of the dreary past. Fortunately, the study of blood-pressure has been revived and carried into clinical medicine, and it is now

safe to talk more freely on the subject. I well remember the days when I was fresh from the physiologic laboratory and proposed to apply physiologic methods in the wards of two great hospitals with which I became connected. The grandiose scorn with which these proposals were met was not cheering, though it has since afforded me much amusement and taught me much regarding what is needed both in medical practice and teaching, as well as forcing me into a line of work where I could be less hampered by the limitations of others.

To understand the circulation one must gain a conception of the actuating force and of the factors of resistance, and must visualize the areas where equal pressure exists. This conception of zones of equal pressure I find rather poorly developed, and am forced to introduce a new word.

Being but poorly qualified in the Greek language, I called on my friend, Dr. John F. X. Jones, a good classical scholar, for proper words to express the conceptions of blood-pressure, and I believe those he suggested wil lbe found useful. "Iso-hemo-dynamic" for the same blood force or pressure, with derivatives shortened in accord with common usage to "iso-hemo-dyne," for lines or zones of equal pressure, and "hemo-dyne" being a unit of blood-pressure.

Normally, these isohemodynes will be found roughly concentrically arranged about the heart, though these lines will not cut the different vessels at equal distances. Every change in an organ will tend to vary the point at which such lines cut the blood-vessels leading to it. All vasomotor changes will move these intersections and all abnormal conditions will affect them.

Whatever changes local blood-pressure tends to change local blood distribution, and consequently affects proportionally the general distribution. It also tends to alter the work of the heart. These changes cannot be ignored if we would study the heart at the postmortem.

Such factors as posture, secretion, digestive activity, absorption, excretion, nervous action, muscular work, compression, shock, hemorrhage, anemias, swellings, inflammation, and all pathologic changes affect the heart in either one or more ways, which may be mechanical, chemical, biologic, or nervous. The condition of the heart as found will not be understood unless we know where the blood of the body is located after death, and its amount and quality; and our estimate of the condition of the heart cannot be finished until we have completed the examination of all the other organs. Every one knows that atheromatous arteries will, if well developed, cause increased work to be thrown on the heart. Most medical men realize that serious lung changes tax the right side of the heart. Many appreciate that digestive disturbances affect the heart's action. All know that weak hearts are eased by rest in bed.

Every factor that we ignore at the postmortem so far vitiates the conclusions we draw.

The caliber of a given heart should correspond with the caliber of its blood-supply taken with the quality of that blood on one side, and

on the other with the caliber of the blood-vessels taken in connection with the demand for blood by the organs to which such vessels go. In considering the caliber of vessels it is not enough to measure their diameters as we find them in death, because variations of elasticity are often extreme and most significant. Nor can we assume that changes found are general. Thus, we may find, as in Fig. 174, the first part of the coronary is enormous, but before we reach the muscle substance itself the vessel may be nearly occluded. I well remember a case where one coronary was quite large throughout; the other large in the first part of its course, but entirely occluded near its middle, the distal distribution being supplied entirely by anastomoses from the coronary on the other side. The heart was large, being well hypertrophied to take up the labor imposed by other atheromatous areas, and had worked for probably years on one coronary, but when subjected to an unusual call for blood to the muscles gave out suddenly.

MUSCLE

The heart muscle undergoes many changes which may be found in almost every degree and often in complicated combinations. Hypertrophy should generally be regarded as a normal effort to meet the demands, but we find large hearts with low percentage of actual muscular elements, and we are often puzzled to give a proper percentum value for the parts and for the whole of the musculature. Fat on the outside should be considered not simply as a mechanical factor, but also as an evidence of the type of nutrition. Fat in the heart muscle is seldom found by the naked eye, though changes in which fat appears are often seen. Fiber forms a normal component of the organ, but its distribution in the different parts is fairly characteristic, and departures from the normal may usually be readily determined. Fibrous substitution is generally a serious matter, and should be studied not simply as to the amount and location, but as to its actual quality and effects. In the muscle substance it generally means a chronic process of long standing; about the orifices it usually signifies inflammatory changes; both give rise to mechanical difficulty for the heart, but of widely different type.

The degree of contraction can only be estimated properly by comparing the lumen and the whole heart mass, with due regard to the amount of the pericardial space occupied.

It must always be remembered that the heart muscle is capable of passing into rigor, and that the heart may not be the first organ to die, in which case greater contraction would be expected, other things being equal; further, it must be remembered how general is the practice of giving overwhelming doses of poisons which tend to contract the heart in persons thought to be *in extremis*.

The degree of contraction is not an index of the power of the muscle, for in hemorrhage, where there is little blood left, one finds at times a fully contracted heart whose muscle is entirely starved and in as bad

condition as in another type of case where extreme dilatation has occurred.

Rapid postmortem changes are common, specially in alcoholics, in those of fat, lax habit, and where serious infection has existed. Here one may find a heart muscle so soft that it resembles wet paper, but other signs tell us that rapid putrefactive changes have been in progress; specially do we find blood decomposition with staining of the tissues.

One should be careful to avoid theories developed by zealous but narrow laboratory workers. A favorite theory of this type is the one that the heart contracts as it passes into rigor. That it may do so is altogether probable, but that it does not do so in the majority of cases

FIG. 176.—A strongly contracted heart with the transverse cut, which shows a very interesting concentric condition of the change which is not rare in cases of true heart failure. The two ventricles and the interventricular wall can be readily compared and studied with the exterior. Note the strikingly contracted auricular appendages; also the reticulum of fibrin over the outer surface.

is perfectly clear from the condition in which we find the organ after death.

The exact time at which a given heart passed into rigor is a difficult and often impossible problem. My own belief is that rigor acts in the heart as it does in voluntary muscles, differing necessarily in detail, of course, and that it is a fixing process rather than one of contraction, and that whatever shrinkage there is, is that of the clot formed of the sarcoplasm. This process may be carried still further by the use of alcohol, heat, or formalin on an already rigid heart. The firmness of the muscle is at times an index of the state of contraction, but it may be almost entirely due to fiber contained in the walls.

The softness depends oftenest on putrefactive changes; often on maceration of weak structure, the histologic measure of which is still unsatisfactory; and on degeneration, whose histology is fairly well developed.

One must always bear in mind rigor and its relaxation. Much can be learned by carefully cutting the heart muscle, but vastly more insight can be obtained by tearing it.

If one compares sections of new cheese, soft rubber, hard rubber, and some vitrified substance simply by looking at them one will hardly realize the differences. The differences in tissues can only be compre-

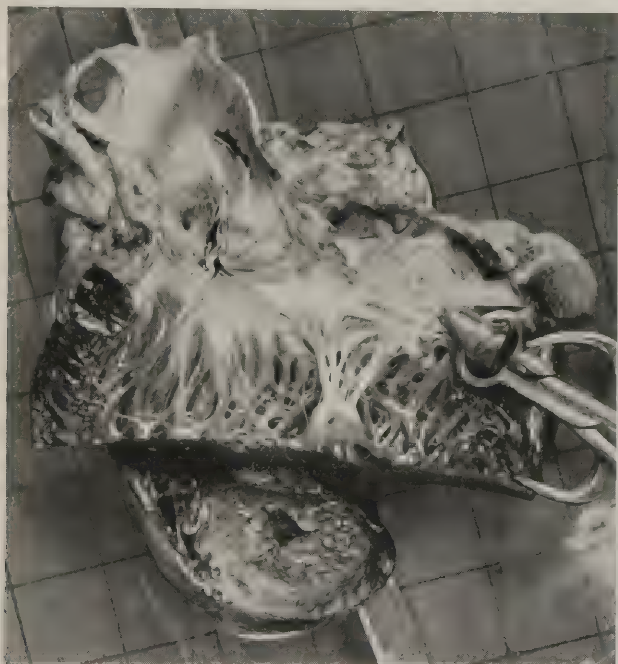


FIG. 177.—The left side opened. Note the very striking way the reticulation of musculature encroaches on the valve base and the marked fibrosis. The almost shredded look of the supports of the mitral valve harmonize with the general type of the heart. (Compare this type with Fig. 184, which is a much less resistant type.)

hended when we pull and stretch and tear and break them, as we do practically with all other substances whose properties we study. I am entirely unable to understand why otherwise intelligent men can continue to study tissues chiefly, if not only, with the eye after section. After gaining some worth while estimate of the quality and quantity of the heart muscle one can profitably study the intricate and difficult architecture. We can only indicate a few of the more important phases of the subject.

ARCHITECTURE

One must study comparative anatomy to fully grasp the foundation plan of the heart. The light thrown by embryology will then add somewhat to a true conception.

One must realize the steps by which the heart passed from a segmented, pulsating tube wherein the propagation wave gradually found a place of maximum impulse, through the steps when the propulsion became more and more limited, to this point of maximum contraction. Here pouches developed with valves. Later one finds the heart assuming the loop form with some twisting, and still later a septum forming the two sides. The essential plan is a looped tube with pouches and valves. The pulsation wave became broken by the growth of a non-pulsating septum between the auricles and the ventricles through which the impulse was transmitted, but so as to be delayed to give time for a cycle of rest and contraction periods. In this tube two sorts of valves were developed, one pair of simple mechanically supported flaps at the entrance to more or less fixed tubes, the other pair deep in the contracting body of the heart, requiring compensating supports with free openings.

Fig. 178.—Type 4. The Left Side Opened.

A probe passes through a stab wound of the aorta just beyond the valve. Note the remarkably smooth interior with flat muscular reticulum. The mitral valve is put on tension by reflecting the muscle-flap to show the action of the muscles of the reticulum on the leaflet. This type is sure to show symptoms, usually called lack of compensation, but really, poor architecture.

The auriculoventricular valves are built into the heart musculature and work more or less automatically during contraction. I am continually being surprised at the lack of comprehension of the significance of this remarkable device. Probably, regurgitation through these valves is vastly more common than supposed. How else would it be possible for the ventricle to pull through the strain of overfilling with its disastrous distention, or to contract against an overload without doing itself or the structures beyond serious damage?

Certain it is that the muscular supports of the auriculoventricular valves play a vastly important part in the work of the heart. These muscular columns are built into the reticulum of the inner layers of the

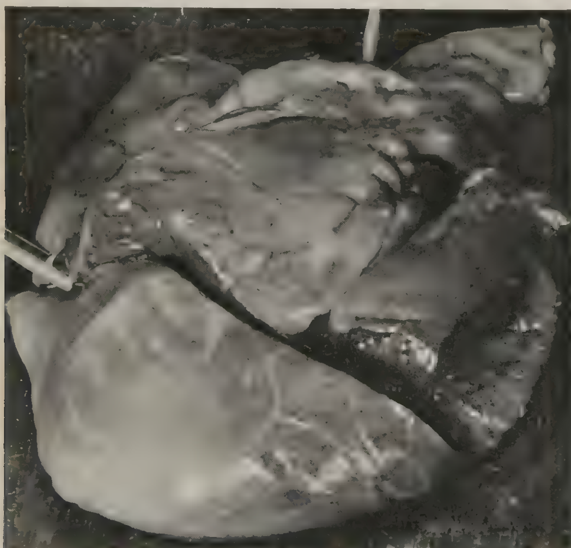


FIG. 179.—THE SAME HEART RECONSTRUCTED.

Note the prominent vessels which show a gray haze of fibrosis; also the distribution of fibrin under the pericardium. The illumination of the different areas brings out this fibrosis more markedly toward the apex, because the light is there reflected from the more superficial layers.

ventricle, and, while associated with the action of the valves, it would appear that they, by pulling on the valves, tend to shorten the heart as well as acting directly on the valves. I am continually impressed by the variety of differences in the muscular architecture of hearts, and have introduced several figures which show this, because I am convinced of the importance of structure as a factor in the mechanical efficiency of the heart, as different from simple bulk or condition.

VALVES

Of the many hundreds of cases I have examined where the immediate cause of death was arrest of the heart, only a small percentage were due to valvular lesions. Relatively too much stress has been laid on the

valves of the heart as a cause of death. This is a natural result of the ease with which valvular lesions can be studied during life and the failure to recognize myocardial conditions or faulty construction.

A little anatomy and pathology will enable one to talk quite satisfactorily about valvulitis, but the problems of heart findings will not be so easily solved. There are a great many types of change which may be found in and about the valves, some of which are not understood. The way the lining of the heart cavities passes out on to the cords and valves and continues into the vessels shows a wide range of variation. Some of these variations can only be understood by a comparison of all the covering and membranous tissues of the body, while others have a purely local character. The translucency or opacity vary independently of the thickness, elasticity, and tensile strength; one sort of thick opaque membrane being extremely tough and elastic, while another is extremely easily torn.

The whole lining of the circulatory apparatus is to be considered together, and the fibrous elements found in the leaflets and in their bases must be regarded separately and in connection with the fibrous status of the body in general and of the arterial system in particular.

Patches of pathologic change, commonly spoken of as atheroma, should be considered with relation to the blood-pressure they are subjected to, and the degree of chemical effect by oxygen and by visceral products and general disease conditions in other parts of the body. It is not enough to measure the leaflets and the general openings and describe the appearance of the surfaces. To gain an adequate knowledge of the condition of these structures one must test their elasticity and tensile strength, and often the process of ripping will show very surprising qualities of structure. This is particularly true as we pass to the great vessels.

The way the valves are seated, and their bases, varies largely within normal limits and more in abnormal conditions.

The nature of the processes that have worked toward the undoing of the organ can often be correctly judged from the manner of departure from the normal of the peculiar type.

In one series we find stout, well-developed valves, with normal amounts of fiber which are well felted. On these may be implanted the endocardial inflammations with erosion, thickening, or growths. Or we may find sturdy valves maintaining themselves alongside of myocardial degeneration or atheroma in the vessels beyond. In another series we see weak, flimsy valves, either thin and translucent or thick, opaque, and weak in fiber. Such valves frequently get pulled out of shape and sometimes bag or even fenestrate or rupture, while the musculature may be fair or even good. More commonly both groups, the fibrinous and the muscular, suffer together under some chemical, organic, or mechanical strain. One should try to understand the fundamental type to which the given sample belonged, and then to understand what has happened to it, both in kind and degree; then, by comparing the general musculature and fibrous development of the body, following this

by a survey of the arteries and veins and of the gastro-intestinal and excretory groups, one begins to be prepared to discuss causes and effects as related to the condition and work of the heart.

VESSELS

The third great group of structures of the heart comprises the vessels.

The sooner one grasps the fact that all anatomy is based on the principle of the number three the better. Leading from the heart pass two great efferent vessels, both pass upward: that from the right heart going up and to the left; that from the left heart going up and to the right, so that during contraction they are pushed upward, and resist downward on the blood column by a combined force which is in an opposite direction to that of the upward thrust of the blood. This downward reaction acts on the heart directly and on the vessels indirectly. The excess of power in thrust in the left side is compensated for in part by the curve of the arch of the aorta. The filling of the great vessels is materially helped by this recoil, which resembles the method of propulsion in squids and octopods.

The afferent vessels enter the auricles in pairs, so that lines drawn through these pairs of openings are nearly at right angles to each other. The axes of the auriculoventricular openings are nearly parallel to the long axis of the heart, pointing slightly forward, in contrast to the axes of the efferent vessels, which curve and point backward in their upward course. These vessels are seated in place with due regard to the strains to which they are subjected, and in disease give way along definite lines.

The amount of pressure in the great vessels may vary enormously without changing the walls, as may be seen where a valve has suffered violence; though the curve of the aorta protects the aortic valve in a beautiful way, a fall on the feet tending to carry the blood away from the heart rather than to it. Certain forms of violence are followed by valvular lesions; these are more apt to be in the nature of blows or crushes.

It is extremely difficult at times to get at the causes for the changes found in the walls of the vessels. We fancy we understand endarteritis fairly well on the basis of modern knowledge of infection, but the conditions of the middle layers of the aorta are often neglected or mistakenly regarded as secondary to endarteritis. Here as elsewhere the method of tearing or teasing the walls yields some very valuable data.

The coronary arteries share the changes in their walls, lining and caliber with the rest of the vascular system, but we too often fail to compare the condition of the heart wall with that of the branches and various areas of these arteries. Such careful comparison might prevent some of the curious errors one sees where local coronary changes have caused myocardial alterations supposed to be due to endocarditis. They are often at fault in cases of sudden death where terminal myocarditis is found.

CONTENTS

The size of the cavities depends upon the degree of contraction at the time of fixation. It is possible that one or more of the cavities may be distended by any cause which produces increased hydrostatic pressure between death and fixation, provided fixation of the heart muscle or rigor does not occur as a true death spasm, which is probably not common. The most likely cause for such a postmortem dilatation in

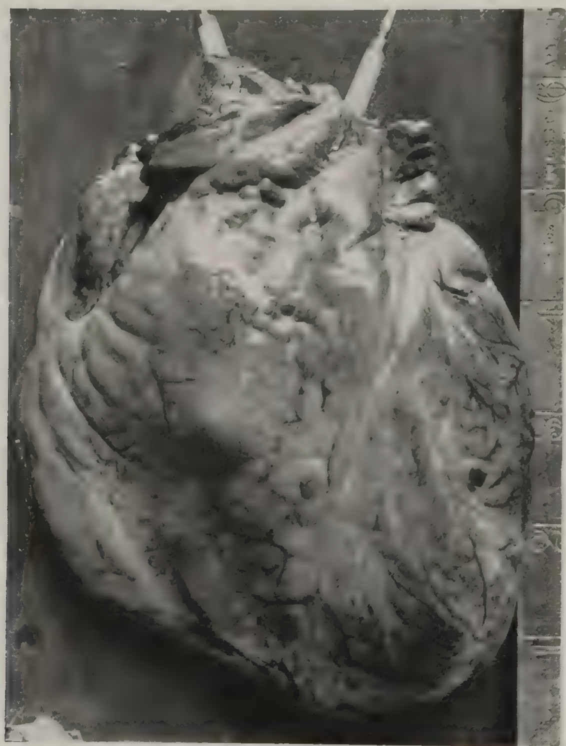


FIG. 180.—FRONT VIEW OF HEART. Type 5, No. 1.

Into the great outgoing vessels instruments have been passed to show the axes along which the recoil takes place during systole. The surface vessels are markedly injected. Note the peculiar mottling, seldom seen, but giving an excellent picture of the distribution of the vessels. The muscle is moderately contracted. The scale at the side is in inches.

the early stages would be posture. A body found suspended head down will often show powerful determination of blood. Most bodies will have reached the horizontal position before the heart stops contracting, but the factor of posture on the postmortem findings in the heart must not be neglected. After rigor has passed off and the internal pressure has become raised by decomposition the heart cavities may be greatly distended. In general, the right side will be more markedly affected by such postmortem changes because of the factors of blood distribution.

It is rare to find the left ventricle showing any great change unless gas production has progressed to a considerable degree.

The degree of filling of the heart cavities will depend in a measure on the way the heart stopped beating. When one finds a heart quite empty, with an unfilled cavity, it is clear something has happened. Either gas has formed and driven out the blood or the blood has drained away through the vessels. This latter is a very general occurrence at ordinary postmortems where little care is taken in opening blood-

FIG. 181.—POSTERIOR SURFACE OF HEART. Type 5, No. 2.

Instruments passing through the auriculoventricular valves are seen to be nearly parallel, and point each toward the apex of its corresponding ventricle. Instruments passing through the double openings indicate the position, and with the other instrument the course of the incoming blood. In order to realize the true position the page must be turned so as to bring the instrument in the left auricular opening to a horizontal or directly right and left position. (Compare with Fig. 180.) The peculiar mottling is even better seen in this picture; also note the peculiar, delicate haziness about the arteries.

vessels about the sternum. Even when clots are found such draining can and often does occur.

The whole subject of heart clots is difficult and not always adequately considered. After death one may find the blood quite fluid wherever it is located. Frequently one finds some degree of clotting unless the examination is made very soon after death. Often one finds true antemortem clots. More often such clots clearly belong to the death or agonic period, that is, to the dying time.

To say that an organized clot is not a thrombus one must carefully study not only the clot but the heart mechanism and the cause of death, as well as the manner of dying.

At the postmortem one finds a variety of clots, varying from softest jelly to firm fibrin masses; some full of corpuscles, others yellow or white. The condition of the blood has a great deal to do with the sort of clot formed under any given set of conditions. After extensive hemorrhage or in severe anemia from other causes one generally finds pale, well-gelatinized clots.

Fig. 182.—A Spontaneous Rupture of the Aorta.

The aorta is filled with gauze, which is seen in the rent that occurred in the inner layer. The outer layer is seen reflected to the left. The wall of the aorta was separated into these two layers by the blood. Only minute rents were made in the outer layers, through which the blood passed to the cavity of the pericardium. There was no pre-existing aneurysm and no sign of serious endocarditis or atheroma. The substance of both layers, however, could be shredded with extreme ease. The heart is firmly contracted and empty.

One must constantly keep in mind the physiology and pathology of the blood in all cases where clots are found. Clots formed after death should not adhere to the structure of the heart wall, and they should show serum, but this can be drained away and not noticed. The essential things to note after observing the color, consistency, and amount of a clot are its distribution, variations in different parts, its tendency to adhere to certain structures, and its behavior when removed and cut, pressed, and torn.

Any staining of the more opaque parts of the endocardium or of the lining of the vessels must be carefully noted, and estimate made relative to the antemortem and postmortem changes in the blood and the time since death and the rate of such changes.

Differences in places are often of great interest, and show much regarding duration and formation, and of the speed of the blood-current during formation.

True endocardial changes will frequently cause spontaneous deposit of more or less colored fibrin, and such masses are often quite firmly adherent, and their removal may change the condition of the lesion.

Interpretation of clots must always begin with an elimination or true estimate of postmortem changes, then the factors commonly producing clots are—

(1) Changes in the composition of the blood.
(2) Changes in the rate of circulation—extrinsic.
(3) Changes in the heart itself—intrinsic.
(4) Changes in the lining—endocardium.
(5) General diseases.
(6) Toxemias, including drugs.
(7) Obstruction to flow (as pneumonias).
(8) Blood-vessel changes.

The age of a clot is probably underestimated. This was impressed on me at a postmortem where the clot was variously estimated by those present from a few minutes to a few hours, but in the center was a pocket of pure pus over $\frac{1}{4}$ inch in diameter with a distinct lining, which could hardly have formed in less than half a day, and probably took much longer.

DISSECTION

Various procedures have been advocated, but the general practice has been to follow Virchow's method. This I have wholly discarded as clumsy and unsatisfactory.

In routine work I gently grasp the tip of the heart, raise it to a vertical position, cut it across the under surface at a right angle to its general axis, at a level about one-third of the distance from the apex to the base. This opens both cavities and displays their contents. This I vary at times by opening right or left side, as I find desirable, in order to more carefully examine the unmixed contents, subsequently cutting the other side. The valves can be seen through the cavity thus opened.

By lifting the heart with a moderate pull and letting it relax again the mobility of the leaflets and their competence can be observed. If blood is present it will rise and fall in the cavity, causing the valves to act. After this blood has been drained away the effect of tension is then observed. These things cannot be done if the heart is disturbed by a longitudinal cut, and the sides of the cut separated. After the con-

dition of the section of the wall and the contents and the valve action have been observed I make cuts with a knife (preferably to scissors) toward the valves, but do not extend these cuts through the valve structure until I have further observed them and am sure where I wish to cut through them.

Each ventricle is finally opened by two such vertical cuts, opening up the valves. The figures show these cuts and the opened heart and serve better than any description, and give an idea how simple the method is, and how much more natural are the positions of the parts

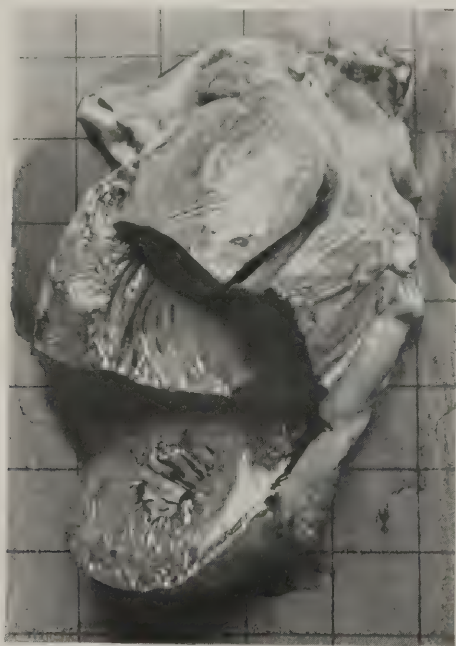


Fig. 183.—A Seventh Type of Heart. No. 1.

The transverse cut shows moderate contraction with much solid muscle and few ridges and very little of the reticulum seen in Type No. 4. There is more work for the coronaries in such a heart, and the surface vessels are, therefore, more prominent. There is considerable fibrosis, which is still better shown in Fig. 184. The background is ruled in inch squares. The method of opening is seen.

than where other methods are employed. Where only anatomic data are to be obtained one can revert to less desirable methods, and one of these methods is by slicing the organ like a loaf of bread, which method is, at times, a very good one. The dissection of the circulatory apparatus *in situ* is at times desirable. My method greatly facilitates such an opening up. Where clots are attached to the heart wall the transverse cut brings them into view without displacing them, and they can then be properly studied; whereas other methods cause more or less tension and displacement when the sides of the cut are spread for inspection.

The simplicity of the method is in its favor. The apex, being left nearly free, can be torn and cut for study of the condition of the muscle without interfering with the more intricate mechanism about the base, which may be preserved for special dissection or for microscopic study. The hydrostatic test can be applied and the working of the valves watched closely, with far more satisfactory results than by the older methods.

While the hydrostatic tests are not what they were once vaunted to be, they are valuable, and should be made in suitable cases and at times simply to enlarge one's grasp of the valve structure and action.

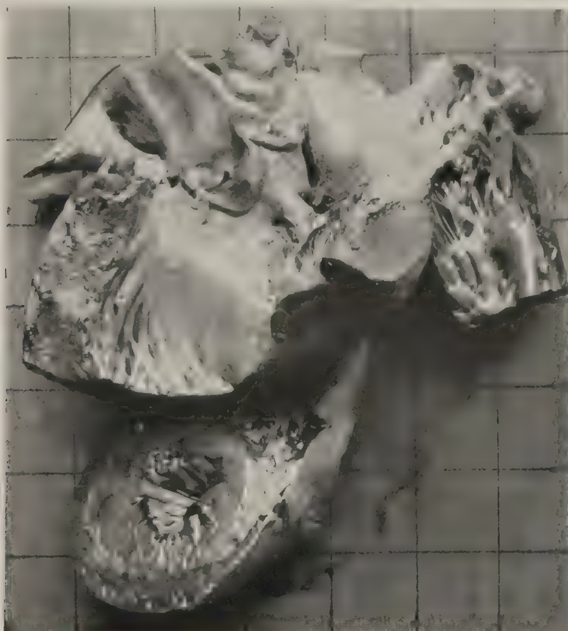


Fig. 184.—Type 7, No. 2. Heart Opened to Show the Aortic Region.

The fibrosis is quite noticeable. In the aortic area it is diffuse, but in the aortic surface of the mitral it is clearly reticulated. (Compare the chorda tendineæ with those in Fig. 177.) Slight irregularity in the cut helps in replacing the parts quickly and exactly.

The coronaries may be palpated in some cases from the surface, and at times all that is needed is to cut them across by transverse cuts not carried too deeply and from $\frac{1}{4}$ to $\frac{1}{2}$ inch apart. A fuller study demands that the pericardium be grasped by fine forceps and cuts made parallel to the vessels, near to but not directly over them; the vessels may then be drawn to one side and freed without injury.

Opening with probe-pointed scissors may be done in special cases, but is not a good routine practice.

Small flexible probes of graded sizes may be used to determine the actual lumen, which is at times important, specially where patches of atheroma are found.

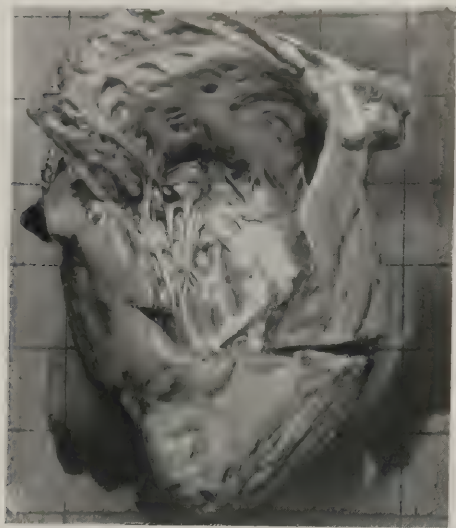


FIG. 185.—TYPE 7, No. 3. THE RIGHT SIDE OPENED TO SHOW THE TRICUSPID SUPPORTS.

It is clear that in this type the muscular action has a considerable influence on the valve. Note the very different way the tricuspid is related to the pulmonary from the relation of the mitral and aortic. The tricuspid does not enter into the pulmonary area, the conus arteriosus being between.

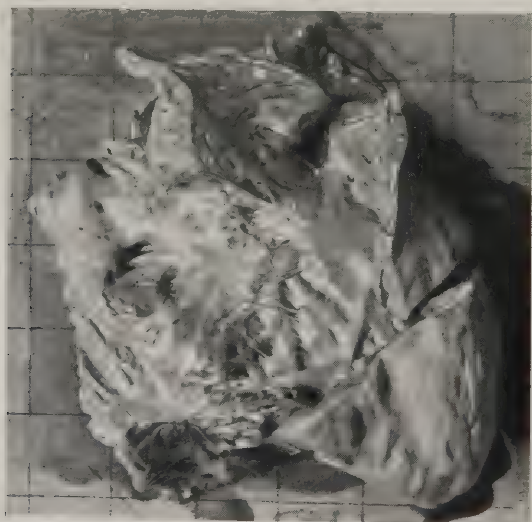


FIG. 186.—TYPE 7, No. 4. THE RIGHT SIDE FULLY OPENED.

Showing the auricle and the expanded tricuspid valve on the left, the conus arteriosus leading to the pulmonary valve on the right. (Compare with Fig. 185.) Note the chorda tendineæ and the rough margins of the leaflets.

GREAT VESSELS

There are many things about blood-vessels which everybody should know, but which, unfortunately, are not applied in practice if known in the abstract.

The position of important vessels is not accidental or haphazard, but has a very definite significance, and no peculiarity of shape or position is without meaning.

The arrangement of the great vessels about the base of the heart is a never-ending wonder, and the crude diagrams in the anatomies seem to be drawn in utter disregard of the part these vessels play in the mechanism of the circulation, specially the share they take in equalizing the thrust of the blood-currents and the rebound of the contracting heart.

Fig. 187.—Type 5, No. 3. Right Ventricle Opened.

The transverse cut gives a clear view of the relative thickness of the two ventricular walls and of the interventricular wall or septum. In the right ventricle is seen a large branched, yellow clot extending to the pulmonary valve, which is held open by a hook. This was seen through the transverse first cut and dissected with full view rather than by blindly following a routine and thereby losing valuable information.

Without such realization it is impossible to understand the causes and effects of diseases affecting them or the philosophy of blood-pressure, a subject receiving such earnest attention at the present time.

The heart must be pulled to demonstrate these lines of resistance, not in a clumsy way, but so that every little movement has its meaning. Then, the connecting tissues being removed, the whole process should be repeated, noting the changes

It will be found that the veins empty themselves in part under such

manipulations, and the significance of a tight or relaxed mediastinum or of aneurysm or tumors will then become vastly clearer, as well as the relation of the adjacent organs to the heart's action.

The vessels will be found to vary greatly in regard to attachment and elasticity even within the realm of the normal, but the changes associated with pathologic conditions are most striking.

FIG. 188.—TYPE 5, NO. 4. THE LEFT SIDE OF THE HEART OPENED AFTER THE TRANSVERSE CUT HAS BEEN MADE.

Note the puckering of the aorta just beyond the valve; also the direction of the irregularities. There is a fibrous haze over the muscle beneath the endocardium, below the valve. The line between the valve seating and the muscle is quite deep and strongly marked. Bits of red clot are seen attached in places. The relation of the two valves (aortic and mitral) is well shown. The heart is a powerful but not a healthy one. (An extra transverse cut is seen below, made for a special purpose.)

In dissecting out vessels a moderately sharp knife is better than a very sharp one, and scissors may occasionally be used, but all cutting had better be done alongside of and parallel to the vessel, thus uncovering and shelling it out rather than cutting directly down on it.

Pulling vessels and parts of vessels is more useful than sectioning them, and in the aorta this frequently shows what cannot be found in any other way. Tearing in the way an expert examines paper will

not rarely show layering and peculiar structure which no other method or any amount of sectioning could possibly reveal.

What I call the "inner bark" appearance, because of its resemblance to the inner bark of the larger branches of a willow tree, is a most important phenomenon, which is associated with good-sized vessels showing limited elasticity, little or no atheroma, general nutritional disorders, and associated with a tendency to myocardial failure, where heart disease has not been suspected. A type of cases where the cause of death is not found at the postmortem if made in the usual manner.

The significance of the lumen as found must depend on the relative size as compared with the body and the organs supplied rather than on

Fig. 189.—Type 5, No. 5. Left Side Opened. (Compare with Fig. 188.)
The intervalvular septum is held to the left by a double hook passing through the aortic leaflet base, and the supports of the edge of the mitral valve are gently drawn downward by three hooks. The auricular lining is thickened. The changed illumination of the ventricular lining shows the surface irregularities, Fig. 188 showing the deeper changes. The mitral leaflet was cut where it forms part of the intervalvular septum.

the actual size alone, and it must be remembered that a highly elastic vessel is capable of considerable change in size, so that the lumen as found may not represent the lumen under normal blood-pressure; therefore we must test the dilatability by using well-controlled and judged forceful dilatation. Quantitative anemias allow the vessels to become smaller, otherwise blood-pressure would fall below the critical point.

If these are long continued the vessels give the appearance of being abnormally small, when they have only adjusted themselves to the mass of blood in the body. Much of what is written about small aortas would not have been written if these principles were more generally applied.

The secondary functions of great vessels—that is, those functions other than simply blood carrying—are seldom thought of, but if one will but study the pulsation of organs at the operating table or in the laboratory, or the throb of the parts on the surface in the clinic, or remember a jumping tooth or inflammation, he will at once realize how very great is this action. Simply grasping the throat from the front and holding it a minute will convince any one of ordinary intelligence that there is a powerful massaging force in the arteries in the neck.

One will not understand pathologic findings at the postmortem unless this action is kept constantly in mind.

Actual inflammatory processes in the walls of the vessels are common in infections and may pass away, or remain and give rise to alterations more or less serious, either with or without apparent gross lesion. One finds changes in the lumen appearing abruptly without local lesion, but generally there is a change in elasticity due to deposit of fibrin.

The habit of cutting a vessel open in the direction of its long axis before examining it has led to the overlooking of many real and vitally important conditions. The cutting of transverse sections and the use of a cone or conical forceps or a hemostat to test the elasticity would prevent such errors, and would not interfere with any subsequent cuts, only these transverse cuts should not be made completely through the vessel, but should leave an uncut strip to preserve continuity. The longitudinal elasticity of vessels is more generally appreciated because they so often retract when cut across that one's attention is called to it by having to hold or recover the cut ends. Both longitudinal and circular elasticity should be tested and estimated and compared before any judgment of the condition of the vessels is arrived at. As in all tissues, texture and composition, color, flexibility, and thickness will be observed, and evidences of inflammation, either present or past, will be noted. Inequalities and tortuosities are to be considered with relation to degree and distribution, cause and effect.

The way a vessel enters an organ is always significant, and its condition in its distribution within that organ is of the greatest importance.

It is sometimes advantageous to force the blood back into the veins in a locality or organ by a milking process. This should only be done after noting carefully the condition existing before such procedure. It will take the place of the blowpipe, the use of which is generally to be avoided.

I prefer, if possible, to avoid opening the vessels until I have made my preliminary examination of the organ.

Lesions involving the vessels are to be studied carefully with regard to their extent, severity, distribution, and relations to the condition of the organs and parts supplied, and all causes or influences duly estimated. The relation of distribution to causation is of the utmost importance.

Owing to their structure and their carrying the returning blood, as well as the less rapid flow and greater dilatability, one finds local conditions extending to the veins more frequently than to the arteries, but periarteritis is less rare than might be supposed from the literature.

CONTENTS

One can profitably think on the origin of the word "artery." The incredible slowness of anatomic progress is truly remarkable. It seems very strange that a meat-eating race, given to violent warfare, should fail to observe that arteries emit, when cut, not air, but blood. Only the deadly reluctance of modern anatomy to receive new thought can make comprehensible why the world waited so long for the conception of the circulation of the blood. The arteries seldom contain air or even gases; rarely do they contain blood in any quantity after death, and in such cases the blood is not always arterial blood, but often returned venous blood.

We have no adequate reason for this phenomenon unless we regard the arteries as part of the whole propelling mechanism, and the heart as merely a specialized segment of it.

Clots we do find in the arteries, but we may find them empty or full beyond the clot. In diseased conditions one is more apt to find blood than in normal conditions, and when the aorta is calcareous there is often blood present. **Air** or **gas** in the arteries is noted only when mixed with the blood, and may occur when some large vein has been opened, though rarely, in spite of the difficult question of how it could get there; generally it is not air, but gas from decomposition.

Much was written about emphysema of tissues following wounding of vessels during difficult labor, but if we will but realize how quickly infection spreads in such cases, and how generally gas-producing bacteria are found to enter the circulation from an injured uterus, and how rapidly general decomposition with free gas production takes place in such cases, we can readily see the wisdom of ignoring most of the literature on the subject. Air will, of course, enter an open vein if the conditions are favorable, and some of it may fail to be absorbed before reaching the left side of the heart.

When I find gas bubbles in vessels that have not been opened I suspect we have some form of gas-producing microörganism in the blood, even when the body appears fresh and there is no other evidence of infection. This is usually proved by the speedy decomposition which follows. Generally one finds staining of the lining of the vessels when there is gas in the contents. The amount of contents should be estimated before cutting or seriously disturbing a vessel or its relations. The amount of contents will be found to vary greatly from what it would be if acted on simply by gravity.

Blood is found coming from the vessels after death, and may flow freely even from small vessels not in a dependent part of the body. This postmortem bleeding varies under different conditions, and should be observed and the causes inquired into. Unusual fluidity of the blood, vascular distention or remaining vascular dilatation, a condition of plethora or hydremia, or some intrathoracic or abdominal pressure may cause such an unusual flow.

The color of the blood when first drawn and the rate of change when exposed in a thin layer, as well as the resultant color of the organs

from the contained blood, should be determined. An organ filled with dark blood of asphyxia must appear different from one filled with the bright red blood of death by cold or in poisoning by carbon monoxid, or from the chocolate brown of chlorate of potash. Ordinarily, one deals only with colors ranging from dull red of partly oxygenated blood to the darker bluish colors of asphyxia, and this scale should be set by painting on the skin a small patch of blood instantly on drawing it by means of a clean knife blade, and by this means we have a standard with which to compare all the tissues and organs.

Such a smear or spread will show the translucency, another important matter; specially is this so in various anemias and following poisonings and in death by electricity. In conditions of anemia, and specially following serious hemorrhage, one finds that the color and translucency change together, but after certain poisons, specially the cyanids, the color and translucency may vary separately; though the more of the poison there is, the deeper the color and the greater the translucency. In simple asphyxia the translucency is but little changed and the color changes rapidly on exposure. In some of the poisonings such oxidation is retarded more or less, depending on the poison and the degree of intoxication.

Special tests on blood, while generally done on the freshly drawn blood of the living, should not be neglected in postmortem work.

Chemical, physical, microscopic, and bacteriologic tests are all usable after death. In general, it must be remembered that after death the red cells are apt to change their shape and gradually lose their coloring to the surrounding fluid (laking). The naked protoplasmic bodies are apt to disappear by death and maceration. The bacteria are apt to greatly increase, and later on other and unusual products begin to appear.

In dilute or very liquid blood the corpuscles may show a tendency to settle or clump. This may be seen as a distinct change with the naked eye. The viscidity of the blood varies considerably even in life, and after death this is with difficulty distinguished from the early stage of clotting.

The rate of clotting can be noted by gathering a little blood on the blade of the knife and letting separate drops fall on a piece of clean skin, glass, or a porcelain tray, drawing an object across one of these drops every few minutes.

Certain blood will clot quickly, while other samples will remain fluid for long periods. Clots within the vessels will always require careful attention. The size, shape, distribution, consistency, color, variation of parts, are all factors to be used in making up one's conclusions regarding the age of the clot, the predisposing and the exciting cause of the clotting. Attachments to the walls and their meaning are always to be thought over carefully, and the size, condition, or degree and location of such areas fully considered. One must not make the serious error of mistaking misplaced clots for antemortem thrombi.

Blood-clots.—There are certain forms of clots found in the blood-vessels that should receive special attention.

Adherent clots may arise either from blood change or from some condition of the walls. Adherent clots filling the lumen of the vessel generally show secondary changes in the tissues. In the veins such clots have usually formed in place. In the arteries they may have so formed or have been carried in the blood-current.

The habit of attributing sudden death to these two forms of clot—thrombosis and embolism—is far too prevalent at present, but so long as it is a comfort to the worried clinician it seems almost hard hearted to object to it. Still, in the interest of right thinking and honest work, some check should be put upon the recklessness so common in this matter. This is particularly to be desired in the class of cases where emboli are attributed to impossible places, as in the coronary artery or brain from fractures, when such masses would surely lodge in the lung, and could by no known means pass into the general circulation directly. In all such occluding clots, whether they completely or only partly close the lumen of the vessel, one should look for the structure in order to determine whether they have been formed in some other position and have undergone bending.

Clots within organs will be studied with those organs and their effects noted. Stratification in clots is often found when they are of any considerable age, as in aneurysms. Why blood forms clots in living vessels is a question about which physiologists have differed as to detail, but it is generally agreed that anything which seriously alters the rate of the blood-current toward retarding it tends to allow clots to form. It is highly probable that slowly moving blood tends to settle and undergo other changes more favorable to the formation of clots.

Any roughness on the surface of the walls of the heart or vessels tends to furnish foci from which clots will grow.

Slight agitation not sufficient to prevent the settling of the corpuscles tends to form clumps which accelerate clotting, both mechanically and by inducing further stasis. Perhaps most important of all are the physical and chemical and vital changes in the blood itself which render clotting easy where before it had not been possible. Clots may be reabsorbed, but one is surprised to find so few cases where such a process can be traced at the postmortem. Hemorrhages may fade quickly, but clots seem to progress more slowly and toward a fibrous residue which is more or less permanent.

We know that shed blood will liquefy after clotting if exposed, and that blood is found liquefied in bodies undergoing decomposition, but one does not find sterile clots, such as occur in hemorrhage between the dura and the skull, undergoing such softening.

Solution of blood-clots may take place in the body, but one seldom finds evidence of such process, at least on any large scale, and absorption seems to be a slow process even when exposed to the blood-current. The changes which do take place in clots are valuable indices as to the age of the clot and the condition of the blood.

Infections are apt to cause such chemical, vital, and toxic disturbances in the blood that clotting is rendered more easy within the vessels even at points far removed from the seat of local infection, and clots are not infrequently found near infections. That infarcts formed by emboli from such clots are apt to show signs of infection points rather clearly to the probable influence of bacteria directly on the blood-corpuscles, causing agglutinations. The effect of certain infections in producing leukocytosis should not be forgotten in considering the formation of clots.

In considering the clots in the heart cavities which extend out into the vessels one is compelled to disagree with certain current statements. It is quite clear that many clots form before death. It is difficult to see how a chicken-fat clot can form in a weakly flowing current of blood, as it is also difficult to see how it will form in normal blood.

It is still more difficult to accept such a theory when we find a red clot superposed on a yellow one, and obtain a history of the heart acting violently until shortly before death, when it weakened, passing into collapse, just giving the proper amount of time for a red clot on top of the yellow one.

My experience leads me to think yellow clots appear where the respiratory content in the blood has been slowly lowered, as in pneumonia. See the beautiful example in Fig. 187, where opium-poisoning was the only significant factor. What the influence of injections of solutions of sodium chlorid may be will not be easily determined, but one finds bad edemas and white clots which seems possibly to connect up with the retention of chlorids in pneumonia. One can safely review the whole physiology of the blood and at one's leisure digest modern hemology, which is perhaps the least balanced of the fads of the day, in spite of its great intrinsic value.

LESIONS

Enlarged vessels are rather common, and it becomes necessary to determine the extent, degree, and duration of the process underlying such enlargement.

Simple enlargement appears where long-continued demand is made for more blood; pathologic enlargement may occur as a result of increased blood-pressure without compensatory strengthening of the vessels, or by reason of disease of the vessel walls.

Obstruction to the flow often produces limited areas of enlargement which may be determined by the balance between the blood-pressure and the strength of the vessel walls, as is seen in the aorta, or may reach to the obstruction, as is seen in old coronary obstructions.

The effect of hydrostatic pressure is seen chiefly in veins of the legs, and in this case is apt to be simple dilatation, the tortuous type more generally being associated with obstruction. Chemical change is a potent factor in causing alteration in the vessels too little considered. Nitrate of silver produces an effect quite as marked as is the coloring

due to the silver pigmentation. Lead frequently is associated with contraction of the vessels.

Ammonia undoubtedly irritates the endothelium, and may account for the prevalence of aneurysm among stable workers.

The subject of the infections is hardly well enough advanced to be properly analyzed. That we find atheroma following syphilis is fully recognized, but what are the exact relations of the bacteria and their products to conditions in the vessels is a subject to be studied more thoroughly.

My own experience leads me to believe that the great majority of atheromatous conditions rest on some long-continued digestive disorder, and I am inclined to the belief that hyperacidity with its secondary enteritis is responsible for a very large proportion of such conditions. Simple senile changes, such as loss of elasticity, are often added to other conditions so as to render the picture more complex. (See Figs. 174, 175.)

In all studies of the complex picture presented it is desirable to bring out clearly all the factors at work, and not jump blindly to the conclusion that because some one causative factor has been found it was the only one that contributed to the result. The mere fact that a person has had syphilis is not all that has to be considered after a history has been obtained or lesions found. We must remember that in one case of syphilis the arteries are affected, in another they escape; it, therefore, remains to be discovered why these cases differ.

After having noted the condition of the vessels in a large number of cases, and at the same time carefully observing the intestines as to contents and condition, I became convinced that a vast number of lesions of the vessels spring from enteric conditions. This is exactly what clear thinking would lead us to expect because of the thousands of forms of protein products developed by the variations of putrefaction in the bowel, and it is evident, from clinical studies of obstructions, infections, and auto-intoxications in the bowel, that many are distinctly poisonous, and it is impossible to conceive it to be possible that the walls of the blood-vessels are not affected by contact and absorption of such toxic substances. It is, therefore, desirable to note the state of distention, condition of disorder, and actual diseases of these two systems together. Remembering that certain toxic substances tend to flaccidity (as certain bacteria liquefy culture-media), while others tend to fibrin deposit (fibroid phthisis), in this connection it is well to consider the general distribution of such changes in the other tissues of the body where relaxation or fibrosis occur. Finally, one must not forget the rôle played by drugs, food, heat, cold, and violence on the vessels.

THORACIC DUCT

Probably few structures of the body receive less attention at the postmortem. Tucked away behind the esophagus, close to the aorta, and between it and the right or major vena azygos. Above it enters the

neck and joins the left subclavian vein, below it ends near the second lumbar vertebræ in the receptaculum chyli.

Possibly we are justified in our neglect of this organ, owing to our slight knowledge of it; possibly we are not. Its position is significant. It is placed in the thorax, and receives the transmitted and somewhat reduced effects of the changes of respiratory intrathoracic pressure, and it receives directly the massage of the aorta and the esophagus; both of these latter, however, have waves going in a direction opposite to the flow of chyle, but this only makes its valves more interesting, and makes it desirable to understand its relation to the "indifferent" tissues in which it is embedded and by which it is attached.

Changes in its caliber and elasticity, as well as obstructions from disease or by pressure of adjacent structures, surely should be studied carefully in obscure cases.

As a path for infections entering the lymph in the abdomen it assumes considerable importance. Too little is known of the part it plays in carrying infection. Statements have been made that it is instrumental in transmitting peritoneal infections to the whole body, specially tuberculosis. It is clear that chemical substances introduced into the body quickly reach this duct, and it is probable that some of the poison of auto-intoxication takes this path.

It is interesting to note the arrangement for discharging its contents above the thorax, so that the wave of lymph propagated upward by expiratory pressure reaches the veins in the neck about the time the inspiratory suction affects them. This device, and its adjustment, is probably far more intimately associated with lymph stases and edemas in heart disease than is dreamed of by the routine workers in clinics and laboratories. The fact that it is in the neck at all should more frequently be remembered in all cases where mechanical factors affecting the base of that structure occur. That a connection exists between metastases to the spine and primary tumors of the breasts is known, but the part played by the thoracic duct and its minor partner on the right side is far from settled. There are many reasons why this structure should receive far better and more thorough investigation.

ESOPHAGUS

The esophagus is most easily studied when the neck and thorax masses are removed together, when it is viewed from behind. For practice it should be dissected out in both ways, from the back of the mass and from the front, so that its relations and attachments may be thoroughly understood. (See Figs. 164, 172.)

The relations are of peculiar significance. The trachea lies along this tube in such a manner that the food bolus in passing down causes a massaging effect in that part of the trachea which is most firmly anchored, giving an interrupted massage to that organ and thereby influencing its tissues as well as tending to displace mucus. This is seen by the tendency to cough up after swallowing in trachitis.

The act of swallowing powerfully acts on the larynx directly, pulling it upward and squeezing it so that the esophageal massage only commences below the cricoid cartilage and that part of the trachea which is forcibly extended by the upward movement of the larynx. This massage is rendered more powerful by reason of the position of the rigid vertebræ behind and the distribution of the mediastinal tissues, as well as by the construction of the trachea, which renders it most easily compressed from behind.

This esophageal blow is transmitted to all the structures near it, and necessarily forms part of the conditioning of these structures, which are also more or less regularly massaged by the aorta.

The tight packing in of the structures in the common base of neck and thorax must be appreciated before the power of this compression can be understood, and it is where the effect of the raising of the larynx in swallowing is completely lost.

The health of the esophagus will assume greater importance in our minds when this matter is appreciated, and deep operations or scars or disease in the base of the neck will contain a factor not frequently given full consideration. A postmortem examination of the esophagus should, therefore, include a rather careful investigation of the changes of the organs which affect this esophageal massage or are affected by it. Changes in the aorta, either hardening or aneurysmal in type, often cause serious modification of the circulatory massage, even to the extreme degree which is seen where tracheal tugging is noted in the neck in life. The rough, massive massage of the lymph spaces of the lower neck and posterior mediastinum undoubtedly has a great influence on the connective structures as well as on the contained nerves.

The condition of the tube itself has received too little attention. There is little chance for mucus to remain attached to the wall, owing to the mechanical effect of the act of swallowing. The wall is so elastic

that stasis, that very common cause of inflammatory processes, is prevented. The color of the lining membrane is always greatly reduced after death, as in all mucous membranes.

The usual evidence, therefore, of inflammation is not found, as in the nose. The mucus present is of a different type from that found elsewhere. This arises naturally from the fact that the secretion is not highly digestive in type as are the buccal and gastric juices, but is of a lubricating or glairy type. The upper part does share in the diffuse inflammations of the pharynx, and the lower part shows frequently the effect of irritation coming from the stomach. Most probably the acid from the stomach reaches only a short distance except in marked cases of eructation or regurgitation, but if this has been excessive one would expect proportional erosion or irritation, and when one finds such one can properly reason as to the gastric history, thus gaining insight into the case not otherwise obtainable.

In not a few cases have errors been made by reason of postmortem changes. These are apt to occur where the contents of the stomach contain a high percentage of pepsin. This may occur after fasting, but usually occurs if death has taken place some time after food has been taken.

The condition should always be considered in relation with the amount of stomach contents, intra-abdominal tension or pressure, and the condition, as well as the amount, of stomach contents.

Cases have been reported of extensive and rapid digestion of organs in the pleural cavity. From my own experience I believe these generally occur where a limited amount of food has been ingested with a full pepsin response, and erosion of the lower segment of the esophagus has been followed by perforation.

Effects of heat and cold appear to have received a ridiculously small amount of attention, and the immediate and remote effects of irritant substances far too little.

The reaction seen in cases of corrosive poisoning shows that the lining of the esophagus differs materially from other mucous membranes, but that it is markedly affected is recognized, and old lesions following such corrosions are occasionally met with.

ORGANS OF RESPIRATION

After surveying the head, neck, and thorax more or less in detail one gains a comprehension of the caliber of the respiratory apparatus, but no itemized list of findings of the parts should be substituted for a few moments of careful study, including observation and thought regarding the apparatus as a whole.

When we remember that a blow on the head will produce irregular respiration; adenoids or a simple catarrh in the nose will materially change not only the function, but in time the organs themselves; that fat in the belly or a pregnant uterus impedes the function; that sexual excesses and tuberculosis are peculiarly associated; that even tight shoes will cause one to hold one's breath, and that occupation and habit have very great influence, we begin to realize how much more there is beside bacteriology and unenlightened anatomy to be considered if we are to talk rationally about the respiratory organs in any given case we are examining. We have to consider a mechanical apparatus of great complexity, consisting of a system of air-passages where the air is warmed, moistened, and mixed and distributed so as to furnish the only direct traffic with the outside world regularly maintained by the body. Coupled with this is the parallel blood system, and supporting both are the groups of tissues and organs of throat and mediastinum.

We should not ignore evidence of mouth breathing at the postmortem, nor should we neglect to value the condition of the external nasal openings or the cavities of the nose, pharynx, and larynx. The action of the epiglottis with its muscular associates, the structures associated with swallowing, vary so considerably within limits of health that different theories are still held regarding exactly what does take place during respiration and swallowing. Not rarely one finds life has ceased because of mechanical conditions about the epiglottis, though these are generally secondary to conditions in nearby organs, specially the larynx.

Mistakes are common enough to make it proper to call particular attention to the structures above the larynx. Foreign bodies, growths, swellings, edemas, paralyses, and inflammations in these parts must not be overlooked. It is not necessary to dissect every case to determine these matters, and the usual methods of examination well known to clinicians and specialists are just as available after death as before; in fact, most of them are more easily applied. One must remember, however, that postmortem change is apt to reduce congestion and edema and produce certain relaxations and rigidities.

THE LARYNX

The larynx is the first part of the air-passage which requires actual dissection, and such dissection is generally not indicated, but when it is to be done one must use the special method required by the conditions of the case. For ordinary purposes the retraction upward of the skin of the front of the neck will sufficiently clear the body of the larynx so that the layers of muscles and the vessels and nerves may be removed satisfactorily. (See Figs. 161–164.)

The mass may then be opened by a cut in the midline in front, or the whole may be removed and subsequently opened.

THE TRACHEA

The trachea is an extremely adjustable tube, both as to length and caliber. Its muscular attachments are complicated in their action, vary enormously in development, and are so delicate that they very generally show signs of any violence inflicted on the deeper structures. The relations with blood-vessels, nerves, and glands are all so intimate that changes in any one are likely to affect the others. The significance of this relationship is of the utmost importance in the study of the spasmodic affections of the air-passages.

The structures holding these parts together are of special interest because of their number and distribution, and because they cause small swellings to produce large effects through their tendency to bind down such swellings, giving rise to pressure effects out of proportion to the actual swellings. Undoubtedly, they help to limit the spread of infection by reason of this same distribution of partitions. The lining of the trachea is far more often effected by acute and chronic catarrhal affections than is recorded in reports of autopsies. The postmortem fading may in part account for this overlooking, but the disregard of the secretions found attached to the mucous membrane is inexcusable. The grade of inflammation can often be judged by this slime covering.

Other matters may be found in the trachea. The most common ones are the foam from the lungs where edema has developed; water in drowning; stomach contents in choking or by postmortem changes; blood from inflammatory or ulcerative processes anywhere along the lower air-passages from spontaneous hemorrhage or from violence. Various matters from the lung may appear. Whatever is found should be accounted for not by the theory of probabilities, but the actual condition of the parts involved. The finer air-passages show similar internal conditions, but their external relations are with an entirely different type of structures.

THE LUNGS

The literature on the lungs is surprisingly full of unimportant details, but lacking in many essentials. I shall give my working conception because I find it extremely useful in practical daily labor over lung problems. There is not much that is new about it but the point

of view. The lung is an irregular-shaped, composite balloon of very elastic material of high tensile strength, in which are packed in perfect order countless minute balloons, all connected up with pipes which unite into larger systems of pipes. These balloons are packed in a delicate but highly resilient and elastic mass or ground substance.

Through this substance runs a system of blood pipes to and from the surfaces of the balloons, which constitute the transfusion surface. Regulator wires (nerves) everywhere control these pipes. This paired, eccentric, big balloon is placed in a box with eccentrically expanding sides and a membranous piston below.

In easy breathing this box and piston expand twenty to thirty times a minute, causing expansion of the big balloon and all the little ones. The box and piston relaxing, the balloons and the packing and the envelope instantly retract or spring together, causing an alternate filling and emptying of the little balloons.

All this is extremely elementary, but seeing as I do dozens of young physicians who have never seen a normal fresh lung distend and contract, nor ever handled one intelligently to find out its physical properties, whose minds are full of the metaphysical vagaries of modern science, but who have not even a decent knowledge of the character of the substance or of the peculiarities of construction as related to work done; and finding men teaching others how to make postmortem examinations who never tried to tear a lung to determine its elasticity or tensile strength, or who dreamed of the changes in these properties that are associated with senility and disease, I am thoroughly convinced of the need of just such elementary conceptions.

I have asked many teachers of anatomy in this and other countries why the lungs were lobed, and from none of them have I ever received a rational answer. It is high time we returned to the consideration of those fundamental elementary matters without which our vast knowledge does but breed confusion. Clear architects' plans are very necessary, but if drawn with such disregard of the physical properties of the material of which the building is constructed as is common among modern medical men, there could by no possibility be a successful building built from them.

The lungs are nothing if not expansile, and the changes in the index of resiliency are of extreme importance in health and disease. The distribution of this elastic packing is peculiar, and these peculiarities have much influence on the significance of the location of lesions. One cannot understand the distribution of disease, whether tubercular or pneumonic, unless one grasps this matter of the distribution of elasticity and something of the reasons for such qualitative structure.

One must consider the coefficient of elasticity that is necessary for the different parts of the lung which will allow of the degree of expansion and contraction necessary for the filling of the thoracic space as it is arranged.

The difference between the apex, which is rounded and moves but little, and the mobile edges is very marked.

The changes that take place in the physical properties of this lung packing or skeleton are very great, but do not adequately show in microscopic sections.

It is necessary, therefore, to use methods of testing at the postmortem which will supplement what the eye can give us. These changes are quite as vital in importance as are bacteriologic considerations.

The general architecture of the lung may be studied by slicing, as a butcher does liver, or, better, by following up the pipes through which the air and blood pass. Lesions of the substance of the lungs may demand special dissection, but such had better be made on commonsense lines, with due regard to the anatomy and pathology, rather than on some cunningly devised scheme for routine practice. The lining of the air-passages is subject to many catarrhal conditions and some serious special infections.

Inflammations spread to adjacent tissues, there causing changes, the extent and degree of which and, so far as possible, their age should be considered. The spread of inflammation, both along the surfaces of the pipes and through their walls, produce different types of lesions, depending on their severity and on the sort of reaction set up in the tissues. In all such cases it is extremely important to note the contents of the air pipes as to consistence, tenacity, and amount, to determine whether the condition is simply one due to occlusion or results from extension of inflammation, or whether there is secondary inflammatory congestion or edema, or whether the inflammation followed some fluid determination.

Often the conditions found will be puzzles which require most careful study of both history and findings before the solution is reached. I have in mind a very striking case where a youth died suddenly following an injection of a horse serum. One pathologist suggested shock; another, edema of the glottis; a third, anaphylaxis. The child had been born with a serious skin eruption for which prompt and vigorous treatment had been used. Soon after this asthma developed, which baffled the physician. This was subdued by a proprietary mixture containing atropin. It was found that exhalations from a horse were sure to bring on a severe attack of asthma. The postmortem showed marked infantilism, with the thyroid, thymus, and lymph-glands involved, edema of the glottis, and marked trachitis. It was clear that life terminated by reason of the edema about the glottis, but what that signified required the history.

The importance of the congenital infection, of the early and intense iodism, of the glandular diathesis, and of the susceptibility to extremely minute quantities of horse products, such as would be inhaled on going into a stable or on riding in a wagon, the effect of atropin in counteracting this effect, the actual tasting the horse serum a few moments after it was injected into the back of the shoulder, and the violence of symptoms of an old type, all these matters far outweighed the simple findings at the postmortem.

Lung conditions are dependent on other organs to a remarkable degree. This is in part recognized in regard to the heart, but only vaguely as to the influence of the brain and nervous system.

The tendency to forget the extremely active nervous mechanism of the lungs is a very bad one. The effect of shock is seen in postoperative pneumonias and hypostatic congestions, where the direct influence of the anesthetic can be eliminated.

Nerve poisons, like alcohol and carbon monoxid, are particularly liable to be associated with fatal pneumonias.

Injuries to the brain of all sorts are almost sure, if severe, to induce edema of the lungs. I have little patience with minds that object to or are incapable of concerning themselves with the factors in lung conditions not bacteriologic. Unfortunately, we do not understand the relations of the abdominal organs to lung conditions, but that is all the more reason why we should apply ourselves to the problem.

The distribution of the lesions is of some value in helping us to localize the causes. Thus, edemas are usually general; congestions, however, vary greatly. However, edemas vary, possibly by reason of the rate of onset and duration. Head caused ones seldom cause leaking into the pleural cavity, whereas those found in heart and kidney conditions are more apt to show pleural effusion. We have to discriminate here as elsewhere between determination, stasis, blood chemical change, blood obstruction, and inflammatory exudate.

It is astonishing that few persons discriminate accurately between the edemas which are formed in the lungs, one type being an intense increase of the natural perspiration by which the air-passages are kept moist, another being a true substance edema; still others being made up of combinations of these two.

True inflammation of any part of the lung must be considered as to the manner of arrival of the exciting cause, the rate and manner of spread, the dissemination of the process including its limitations, and whether distribution is even or consists of separate foci.

Simple pneumonias require little skill for their general detection and description, but special localized pneumonitis often presents serious difficulties. Thus, bruises of the lung which are followed by inflammation are far from simple matters because every factor must be most carefully scrutinized. Traumatic pneumonitis will always remain difficult to analyze.

The problems associated with industrial disorders, including dusts of various sorts, vapors, gases, and injuries and sequelæ, are just beginning to receive attention.

After having determined the condition of the lung substance as to its constitution and its properties, degree of congestion, inflammation, or other unusual matters, including abscess, pneumonia, cavity, deposits, tumors, scars, adhesions, infarcts, glands, blood-vessel changes; and having determined the amount and kind of changes in the air-passages, regarding walls, lining and contents, congestion, inflammation, thickening, erosion, obstruction, one is ready to review the findings with

the purpose of determining what relation the separate findings have to each other.

Thus emphysema, combined with disease of the air-pipes of the lung, is a very different thing from that found following violence, severe cough, relaxation of the elastic packing, and still different is that of gas-producing decomposition. Also hemorrhage will be found to vary from a diffuse leaking, in cases of passive congestion or purpuric conditions, to massive outpouring in rupture of an aneurysm, but also differs when found connected with the specific infections, pneumococcus, tuberculosis, syphilis.

If one would understand hemorrhage in the respiratory apparatus one should first master nose-bleeding, or, if that is too difficult, at least consider the vast variety of conditions which cause it.

Fig. 190.—Lung with Pleurisy.

The right lung has been lifted out and shows a thick layer of yellow gelatinous lymph over the lower lobe. Here the color shows clearly that the infection was not a direct one, but that the culture had filtered through some resisting tissue, in this case the diaphragm. Below the diaphragm a severe mixed infection with dingy pus and but little lymph; above the diaphragm little pus and much lymph. It is from such findings as these that we learn the way infections spread through the different tissues and structures. (Compare with Fig. 191, where the photograph was printed longer, giving darker effects. Each one shows special characters.)

The determination of the bleeding-point can usually be made, but in not a few cases this is quite impossible, but the type and the amount and character of the bloody discharge can be determined.

Rarely will blood be found in the lungs that has come from a point above the larynx, but in case of violence, where considerable blood is liberated into any part of the air-passages, it will be carried into any other part. It is not uncommon for persons whose throats have been cut to drown in their own blood, particularly if a large vessel has been cut. In estimating the amount of bleeding one must remember the frequency with which blood from the air-passages is swallowed. One case caused me much trouble because no blood was spit out from the mouth; later, however, a bucket was produced into which the man had

vomited a quart of frothy blood mixed with food and partly changed by the gastric juice. The stomach was nearly empty at the examination and very little blood in the lung. The bleeding had been slow and from a small superficial vessel ruptured by violent coughing, and was only found with difficulty; there was no cavity.

Certain postmortem changes take place in the lung at different rates and to a very variable degree.

The collapse which should take place on opening the chest of a fresh body will not be found after edema, congestion, pneumonia, loss of

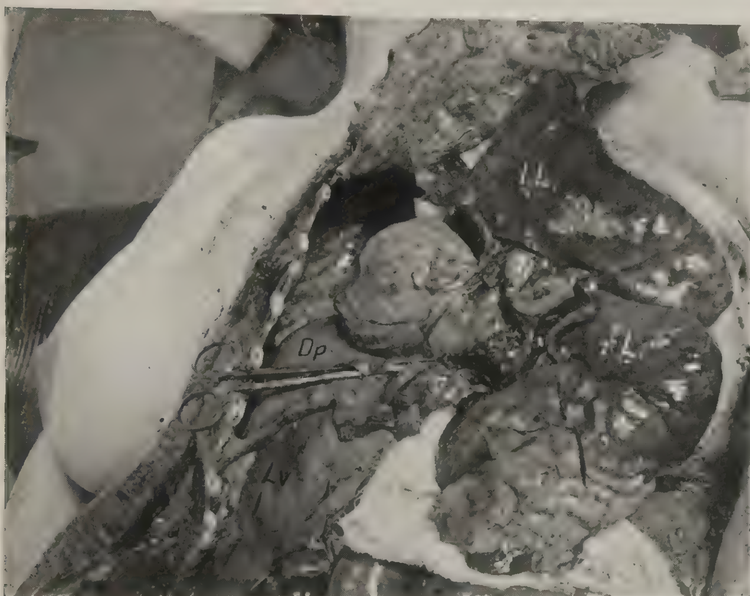


FIG. 191.—The trachea (*Tr.*) has been opened after severing it; both lungs being lifted out and laid over, the apices and posterior surfaces being in sight. The color of the adherent lymph is to be compared with the white cloth under the right lung and is also to be compared with the roughened surface of the liver (*Lv.*). The upper surface of the diaphragm (*Dp.*) is seen to be smooth and free from adherent lymph. Small areas of congestion dot the surfaces of both lungs. The left base is generally but moderately congested. Note the general trachitis and bronchitis. It will be seen that the only damage to the pulmonary vessels is slight torsion, and they can now be studied fully, which would be impossible if the organs had been removed in the usual manner. A cut was then made in the pulmonary artery and a red clot, grasped by the forceps, extends into the right pulmonary artery.

elasticity by senility, or disease or fibrosis, or obstruction to the air-passages.

Such collapse may have taken place before the body is opened; the longer the time since death, the more likely this is to be the case by reason of the escape of gas into the pleural cavity.

The position of the blood will often change; simple settling is very common.

Congestion to engorgement, by increased abdominal tension forcing the blood into the thoracic vessels, is often extreme where decompo-

sition within the belly has advanced. Leaking of fluids into the pleural cavity may simulate pleural exudate or hemorrhage. Such leaking may follow edema, congestion, postmortem displacement of blood, or from some condition of the body; or is found in drowning, usually only after some time has elapsed since death, but in purpuric or alcoholic cases one may find such evident leaking while the body is still warm.

FIG. 192.—A LUNG THAT HAS BUT SLIGHTLY CONTRACTED OWING TO EDEMA. SEEN FROM THE SIDE.

Note the separate areas of congestion and how the lobes are constructed to shoot down and forward, during expansion, to fill the thoracic space. The middle lobe has a long excursion to make on a line drawn from the apex to its free tip. The upper lobe expands along radii from a point below and in front of the apex. The lower lobe expands more like a balloon, but its anterior point has a marked excursion. These parts show different resistance to the knife and to tearing and pulling.

The escape of gas on opening the chest is not common in persons recently dead. Rarely one finds that when a person has died fasting the gastric juice has eaten through the stomach wall, diaphragm, and into the organs beyond.

In removing fluids from the pleural cavity care should be taken to first note the position of the lung—generally it floats on top—but if clots are found their distribution is by no means in accord with simple

hydrostatics. This will be found to accord with what I have already said about the distribution of elastic substance in the lung.

The same holds true of pus and lymph in pleurisy, but other factors come in to still further modify their distribution, particularly the condition of the adjacent tissues and the place from which the infection started. Restriction of motion of part of the chest wall or diaphragm

Fig. 193.—This lung contains an area of consolidation in the base, the remainder being congested. Below, at the left, this pneumonic area is sectioned; above it has been fractured, and while the extreme difficulty of obtaining a satisfactory photograph of such a mass of uniformly red tissue has only partly been successfully overcome, one can easily make out the marked difference of surface between the cut and fractured portions. Note the irregular lumpiness of the broken area and the characteristic type of the lumps, which indicates the degree of internal tension in the skeletal units. No suggestion of this is found in the section. Also the way the fracture can be made to follow the air channels.

tend to further influence such distribution. Crepitation of the lung tissue under pressure is very apt to be misleading unless one regards the degree of collapse, the amount of fluid present, and the postmortem changes. The hydrostatic or immersion test is only of value when carefully made, and when duly guarded by consideration of the factors influencing the specific gravity of the tissue.

LESIONS

Diseases by extension may pass to the organs of respiration from any of the adjacent structures, more particularly from the diaphragm and chest wall, though cardiac, spinal, and throat lesions not rarely extend in this direction. By transfer we find many conditions, chiefly emboli, metastatic tumors, and infection. Asthmas form an exceedingly difficult group, varying greatly as to cause, from simple local spasm or inflammation to neuroses and extraneous pressure; some even seem to be purely chemical results of perturbations of the internal secretions.

Asphyxia may result from simple respiratory failure, as in central nerve lesion due to disease, violence or poison, or come from obstruction of the air-passages, either internal or by external pressure. True respiratory exhaustion occurs in old age and wasting disease quite often. Vascular engorgement and edema of any part of the apparatus, but specially about the rima glottidis and in the lung substance are not rare.

The picture presented at the postmortem varies greatly, depending on the vitality of the other organs. Usually there is actual determination of blood of a dark color to the lungs. Small hemorrhages are common where violence or sudden occlusion has occurred while the person was in good health.

THE ABDOMEN

In previous sections certain of the general considerations were discussed, but the abdomen presents a number of peculiar problems.

The containing walls show a fixed base below at the pelvic rim; all else is mobile. This mobility is of two distinct types—the one due to the bendings of the spine, which is here most freely movable in life, but firmly fixed after rigor mortis sets in; the other type is by contractile masses or sheets, the diaphragm above, the belly wall in front, and the pelvic floor below.

The respiratory rhythm keeps the contents as well as the muscles of the walls in constant motion. It would be unreasonable to suppose that such motion did not have important effects on the organs even if such effects had not been clinically noted.

The best place to study the abdominal motions is not the dissecting table or the laboratory, but the gymnasium. After such study and while the mental pictures are fresh the dissection will be vastly more profitable. It will then be easier to consider what each movement does to the contained organs. What are the effects of flexion, compression, displacement, or massage; and the mechanical effects on the blood and lymph and the contents of the hollow organs; also the different effects produced when these contents are varied, as they are by eating and drinking?

This mobility of the abdominal sac takes place so easily in health that we are seldom aware of the extent and effect until some inflammation calls our attention to it.

The board-like rigidity of peritonitis is simply an attempt to limit this motion. This frequently remains as cramp spasm after death. No better example could be found of the need of using knowledge acquired by the study of the living at the postmortem than in the matter of abdominal motion.

One would hardly imagine that the lumbar spine was mobile if one had only studied it after death because of the intensity of rigor which firmly fixes these vertebræ in place.

In the normal healthy viscera there is in life a great migration or oscillation of the organs. The contents of a full stomach cause a movement downward and to the right; this is replaced by an upward pressure as the small intestine receives the stomach contents, which is in turn followed by pressure upward and to the left when the intestinal contents reach the head of the colon. The passage along the colon causes a more or less complicated downward twist to be transmitted to the abdominal contents, revolving as the hands of a clock. The collection of fecal matter in the rectum and of urine in the bladder, causing

Fig. 194.—A Flat Type of Belly.

The abdomen has been opened before the thorax and the organs are seen to project well up under the diaphragm. The muscular part of the wall is thin, while the fibrous inner layer is thickened. The intestines cover the pelvic organs completely. Note the contracted colon and its peculiar position. (Compare with Fig. 195, where it has been distended; compare also with other types seen in Figs. 82 to 97.)

Fig. 195.—The small gut has been lifted to the left side; air has been pumped into the vermiform appendix; the colon is seen to be of normal size. Note the complete competence of the ileocecal valve, no air having passed into the ilium, though distention was subsequently carried almost to the bursting point of the colon. The bladder (*Bl.*), which is empty, shows foldings. The uterus (*U.*) is markedly displaced. The left ovary (*ov.*) rests on the sacro-iliac junction and the tube (*tb.*) rises over the brim of the pelvis.

an upward pressure as well as pelvic compression, which is relieved on the discharge of the contents.

It is as patently futile to attempt to comprehend the effect of disease or operations about the belly without an understanding of these natural movements within as it is to ignore the motions of the chest in a fractured rib, and the opportunity to master these problems at the postmortem should not be neglected.

If there is gas in the gut it can be displaced systematically to demonstrate all these movements, or air or water can be easily run in by means of a cannula, a piece of rubber tube, and a tire pump. This can be rendered more striking if the peritoneum is left intact, except for small windows cut in it for the injecting. Then the gut will be seen to arrange itself under the action of the various forces. After this has been observed in a normal belly, one is ready to mark the differences seen when fat, adhesions, hypertrophies, or diseases give modifying conditions.

While this admittedly savors of experimental work, one must never forget that postmortem examinations are little more than pompous, pedantic foolishness if they do not help to an understanding of everything that is present in the body, not simply pathologic tissues, but mechanisms working to a purpose, and organs performing complex functions under mechanical, chemical, and biologic conditions, every one of which is intimately connected with health and disease.

THE PERITONEUM

The peritoneum varies with other fiber-containing structures in many nutritional and infectious conditions. It varies apart from the general fibrous harmony, and it is still further modified by local inflammations. These variations are of degree and kind. One case will show thin, highly glazed, almost transparent membrane of relatively great tensile strength, while another will have a thick, cloudy, barely smooth appearance and low tensile strength; a third may be tense, yellowish, and powerful. Yet all these may be entirely normal for the individual; if, however, some disease affects the structure the manifestations will vary in each case as much if not more on account of the structure than because of the peculiarities of the disease itself. It is not always easy to comprehend the peculiarities exhibited by the peritoneum, but it is entirely inexcusable to ignore them on that account. The permeability of the peritoneum to infection is generally very slight, but this varies much.

The distribution of inflammation depends in part on the character of the infection and in part on the normal motions in the belly, and also on the place from which it is infected. The nature of the reaction is shown by the contents of the belly as well as the condition of the membrane. In general, avoid cutting as much as possible during the preliminary study of the whole topography and condition of this membrane.

The peritoneum may be regarded as the inner lining of the walls

of the cavity. We should have another word for the more delicate covering of the viscera; perhaps, however, it would be best for the present to ignore the archaic crudities of anatomic nomenclature, and try to grasp the principles of construction and functions of the groups or subdivisions of so-called peritoneal structures.

These consist of three very distinct groups: (*a*) the lining of the cavities; (*b*) the coverings of the viscera; and (*c*) the omental tissues. They differ in thickness, tensile strength, and vascularity to such a

Fig. 196.—Peritonitis.

Here the belly wall, which contained considerable fat, was laid out with ease owing to relaxation. The whole peritoneal cavity was bathed with pus, which may be seen in little puddles about the omentum, which is thick and long. The peritoneum is clouded and covered with a fine deposit. The colon is so embedded in omentum that only its outline is to be traced. Note the different types of peritonitis in the stomach and the anterior belly wall; also the deep pits in the omentum. This photograph was taken with the light coming from in front of the camera to bring out the surface conditions. The infection arose by extension from the pelvis.

degree that we simply must not confuse them when we study the belly.

Another very commonly made error is to consider adventitious lymph deposits as peritoneal structures. Whether we will regard ligaments found in the belly as folds of peritoneum or separate structures about which this membrane folds is largely a matter of opinion, but it seems a bit more reasonable to regard them as separate structures, specially if we retain the one term for the common covering membrane.

Such ligamentous structures belong to the organs they anchor as well as to the covering, and to the general abdominal topography which

they either do or do not help to maintain. Every grade of change of texture, structure, and development—infiltrations, inflammations, congestions, growths, adhesions, scars—must be observed and valued.

OMENTAL STRUCTURES

The older notion of the function of the great omentum as a sort of kite's tail or position-retaining mechanism seems to have some slight truth in it, but one finds the organs in place where it is surprisingly small. Its function as a protection against cold probably depends more on its vascularity than on its structure. This appears to be borne out by the general tendency of the fat and vascular development to compensate the one for the other.

The vascularity still remains as an unexplained feature, even supposing that there is considerable importance to its function as a thermal pad. My experience leads me to conclude that intestinal disorders are more apt to be found when the great omentum shows weak development, which fits well with our recently accented knowledge that woolen belly-bands tend to reduce the frequency and severity of enteric disorders.

In examining this structure we must note its shape, size, and development as well as its vascularity; its fat and fibrous content, and these taken in connection with the condition and position of the organs with which it has relations. The lesser and the gastrosplenic omentum, as well as the gastrocolic, should be considered as ligaments in spite of their origin and resemblance to the free pendent portion of the great omentum. The omentum furnishes us with the best means of judging of the effects of fluids, particularly those escaping from the digestive tract by perforation.

ABNORMAL CONTENTS—FLUIDS

The effect of stomach contents in the peritoneum is first a marked, almost violent congestion, with reaction by exudation. This congestion usually remains after death to a considerable extent, if, indeed, it is much changed. Perforations after death are common enough to make it desirable to know the difference in the picture produced in such manner as well as that by true antemortem leaking.

A certain amount of digestion takes place after death in each case, but I have found it to be much less where the perforation was antemortem. The reaction appears to be a successful attempt to resist such digestion.

In postmortem perforation the structures show a grayish slime, the result of the digestion and dissolving of the structures, including the contained blood. Such findings have not rarely been mistaken for the effect of some corrosive poison.

In actual poisoning this effect is at times found, but is then generally due to digestive action following injury to the stomach wall with perforation. Pancreatic fluid causes characteristic milky points in the fat and actual digestion of the tissues and the contained blood, followed by

marked color changes. Bile appears to have a striking effect on fibrin and lymph, often retarding union and adhesion formation.

Urine, being seldom sterile, is very apt to start early infection, but it has several other effects that should be kept in mind—its acidity and large saline content both affect badly the delicate membranes, which resent any but isotonic solutions. Generally one has little difficulty in recognizing the nature of the fluid by its odor.

Intestinal contents, while alkaline, and, therefore, more apt to show less angry reaction than gastric contents, are loaded with a mass of microörganisms which give rise to almost instant infection.

The distribution of infection in the abdomen is a largely unsolved riddle as yet. Where much fluid pus exists, of course, it will be general, but in the comparatively dry forms none of the recognized factors of spreading infection will satisfactorily explain certain observed conditions. It is well, however, to bear in mind the more important of these factors: (1) direct growth of the organism; (2) peristalsis; (3) the respiratory cycle or oscillation; (4) circulatory transmission waves; (5) posture of body; (6) distention of the gut; (7) the tension and elasticity of the supports, attachments, and ligaments.

At all times the signs of reaction in the various parts of the peritoneum are of the utmost importance in determining the quality of the fluid as well as settling the question of the effect produced, and will help materially to determine the manner of distribution and the age of the condition.

Blood seems to clot very readily in the abdomen, though this cannot be positively stated, owing to the extreme difficulty of determining the factors of blood-clotting in any given case. It is more than probable that the varied motions and the peculiarities of surface tend to influence clotting.

It is rarely difficult to find the bleeding point. There is not rarely considerable difficulty in determining the amount of blood in a mixed fluid found in the abdominal cavity. It is not always easy to be sure, even where clots have formed, because of the seemingly erratic distribution of fluids during life and to a less degree after death.

Coagulable fluids if mixed with blood may mislead one to overestimate the actual hemorrhage.

Occasionally clots of different firmness, color, or consistency can be considered as of different age, and if but one source is found, one may infer different hemorrhages. It must be remembered that in any severe bleeding the first and the last blood poured out will give rise to materially different clots. Mixed fluids may tend to modify each other. This is specially true of gastric juice and blood, which if poured out together will give a very different picture from that produced by either one separately, the blood tending to neutralize the gastric juice and the juice to digest the blood.

The examination of the various fluids requires so little technical skill that there is no excuse for neglecting it.

Albumin, globulin, and bile by chemical tests; then with specific

gravity, reaction, opacity, coagulability, viscosity, turbidity, and sediment; and the microscopic examination for cellular elements.

The accurate quantitative work required in elaborate investigations is not necessary or desirable, but quick, rough tests are most valuable at the postmortem. The significance of various fluids found in the belly is far from clear, and of the actual origin little is known. We must be content to observe those conditions which we find in the organs, specially heart, liver, and kidney at the same time, without following the rather sophomoric physiology that is invoked to explain the relationship. Pus varies in every particular—of composition, color, consistency, distribution, admixture with other fluids, and bacterial content.

Where possible, we should determine the significance of the conditions existing in the belly with relation to each of these qualities of the pus present. Bacteriologic tests are most valuable, but they only supplement the observations on a broader scale.

Obstruction to the flow of lymph and chyle will at times be found to cause characteristic fluids in the belly and pelvis.

Rupture of cysts, while not very common, may occur when least expected. The effect will vary with the type of cyst, from simple collections of limpid fluid when the cyst contained sterile fluid, to violent inflammatory reaction when dermoids are ruptured, or concentrated, or irritating, or infected materials are discharged.

It is desirable to form some reasonable estimate of the nature of the material which presents in the first opening of the belly in order that the investigation may be made in a rational manner rather than by routine rule. Abscesses not rarely discharge into the belly cavity, and these oftenest occur in the pelvic part, and the true abdominal cavity is reached by extension. When extra-uterine pregnancies terminate by rupture the ovum or fetus is not rarely discharged and may be completely covered by clots. Bullets are not infrequently so engaged. It is, therefore, desirable to retain all clots removed from any part of the body in a clean basin until one can carefully examine them or has determined whether such examination is desirable.

GLANDULAR BODIES

In many conditions one finds the lymph bodies enlarged or congested, sometimes pigmented, often diffusely infected; at times undergoing degeneration, every such body or gland is a warning to go carefully, and, so far as possible, the reason for the condition should be found. These glands generally are confined to the more important lymph paths, specially in the mesenteries and along the spine.

Each separate gland should furnish data as to the location, extent, degree, and duration of the causative process, and often will indicate the type of infection and something of the bodily resistance.

Groups of glands, by their size, position, relative condition, and distribution, tell of the concentration of leukocyte armies and invaders. I find it not unprofitable, though possibly a trifle fanciful, to study the

strategies of this germ war for a place in the body. The pangermic hordes meet with no little resistance, but we too often forget how such resistance is organized and what lines of communications, barriers, hospitals, burial grounds exist, while following some present-day fad of bac-

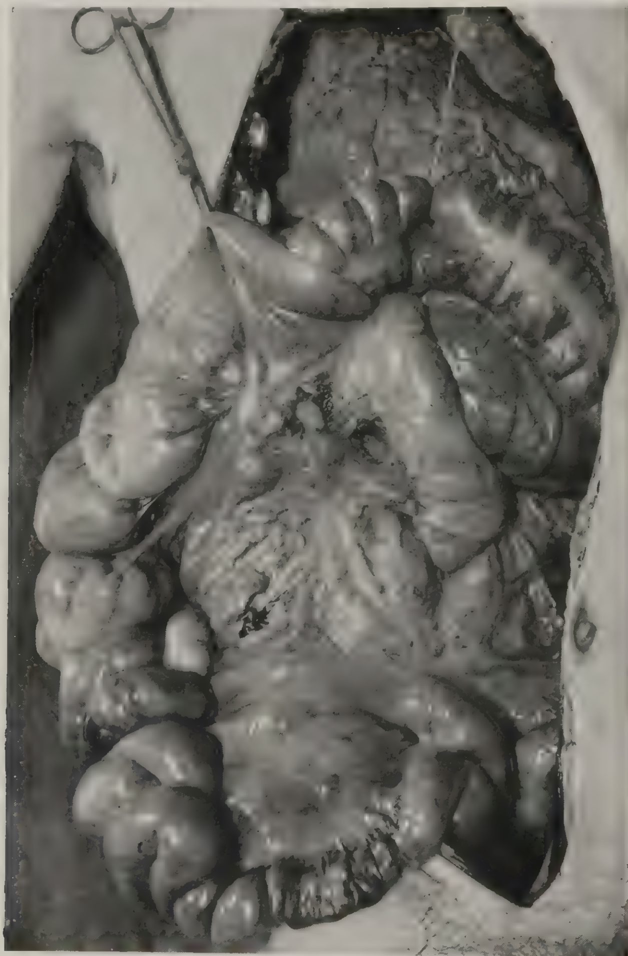


FIG. 197.—Several areas in the small intestine are seen to be darker in color. One of these segments is spread out on the groin and the associated lymph-glands are easily seen in the mesentery. The peritoneum has been removed in the central part of the picture to show how these glands are embedded and their relations. The whole gut is seen to be thin and much injected. The upper part is lighter in color and less clearly affected by the enteritis, which was severe and of long standing. Note also the slight retraction of the lungs; and the umbilicus, which is badly formed, as is common in inherited nutritional conditions.

teriologic laboratory origin; glittering hypotheses of infection and immunity will rise and fade away, but the great fundamental fact of war of millions of units at the front with organic backing, personal encounter, and chemical ammunition will grow clearer in the minds of those who understand disease.

Not a little of what has gone on at the front is to be comprehended by a glance at the hospitals. The glands pretty well represent hospitals in the war of invasion.

If the fighting has been severe at a given point the hospitals will be filled along the line of communication from that point. I find this very simple truth too often forgotten at postmortems.

Nowhere else does one so often need to remember what are the lines of communication as in the abdomen (and that subdivision, the pelvis, is included). The glands included in the folds of the peritoneum are generally so close to the cause that little difficulty is found in tracing the paths of communication and locating the battleground.

The retroperitoneal or prespinal glands, however, require more careful study before one can safely say from which battlefield they are drawing the wreckage.

One simply must understand clearly the lymphatic system in and about the belly, as well as the paths leading to and from it. Nowhere is reckless cutting more disastrous. Nowhere is it more common.

THE SPLEEN

The architectural simplicity of this organ tempts one to overlook many important matters. Its position has a definite meaning. It glides and is alternately compressed and relaxed by the motion of the diaphragm. It receives compression from the stomach in proportion to the distention of that organ when it is normally situated, and does not receive its usual periodic squeezing in severe gastroptosis, and does not have full relief in continuous gastric distention. It is protected by the ribs from outside force, but these, in turn, form a wall against which it is squeezed by the stomach. It is not directly massaged by adjacent blood-vessels, but is one of the pulsating organs, being freely but gently acted on by intrinsic vessels. It is particularly sensitive to certain infections, notably malaria and typhoid, but many of the diseases where the blood is directly invaded show some change in the spleen.

The nature of the organ makes it sensitive to obstruction to the return flow of blood, but I am firmly convinced that the enlargement seen in severe liver disease is far more correctly interpreted as a compensatory hypertrophy than as a simple passive congestion. Hypertrophy is common enough to make it difficult to say just what its size should be. So far as possible we must endeavor to estimate how such variations of position, fixation, circulation, and tissue condition are related to its functions, and how these are, in turn, related to the condition of the blood and the other organs and to the various infections.

Histology has about exhausted its resources on this organ, and we are still groping in very dim light regarding the functions. It is clearly necessary for us to return to a more thorough study of its qualities as a whole for further understanding.

The nature of the tissue makes it highly sensitive to postmortem changes, so that all estimates of its condition must be made only after

determining the stage of such changes. This having been done, one must carefully note the consistency. The softness or semifluid condition of the parenchyma may undergo severe changes, but these may be masked by the condition of the interstitial structures. Many spleens will appear firm simply because the fibrous skeleton is increased, while the parenchyma is little firmer than soft mush. I know of only one way of investigating this, and that is by actually tearing the organ; cutting will not show this condition.

I am inclined to look on softening of the parenchyma, apart from postmortem softening, as a rather serious matter, generally associated with some direct chemical action on the cells. Compensatory hypertrophy generally shows firmness. It is clear that an organ whose function varies in amount must have an elastic capsule to allow it to expand under stress. One must regard thickening or loss of elasticity of the capsule as far more serious with the spleen than with most organs.

The spleen is to be studied as part of the lymphoid or undifferentiated tissue of the body. It is probably capable of responding to chemical influences as only undifferentiated tissues can, and specially is this true of the chemicals forming the blood.

That it can be entirely removed without causing grave symptoms goes far toward proving that its parenchyma is not specialized, as is that of the parathyroids or pituitary body, for chemical production.

I must confess that the spleen is the hardest visceral organ (excluding the brain) to interpret. The only helpful literature I find is that which considers it in relation with the organs and conditions, which I believe is the only way at present to regard it.

SUPRARENAL BODIES

At present it seems almost a waste of time to do much with these bodies because our knowledge is so unsatisfactory.

It is our duty, however, to face the problems squarely and continue earnestly to try to understand them.

The rapidly increasing use of adrenalin clinically should soon help us to realize the effects of the specific chemical substances on the other organs. It has become clear already that these substances profoundly influence the blood-vessels. The origin and relations of these bodies is most suggestive of a high chemical, vital significance. They are so placed as to receive considerable rhythmic massage from the diaphragm, and they share the effects of varied abdominal conditions while being placed out of the direct line of movements of the gut.

They are bedded in the perirenal tissues, and appear somewhat different in fat persons, where the adjacent fat interferes with mechanical compression and relaxation. They vary largely in color, texture, size, shape, and cellular distribution, but we have only begun to observe the significance and coincident variations in other organs from which future observers will learn much.

I have often noted the different types that are found in different

sorts of individuals, but am far from satisfied as to which is cause and which is effect.

There was formerly a tendency to attribute bronzing of the skin to tuberculosis of these bodies, but a larger view shows that such bronzing is not rare where no disease is found in them. The probability is that we have been ignoring these bodies at the wrong time, and that when we look at them more critically in our routine work, describing their macroscopic variations more carefully, we will be astonished at our findings.

Years ago I was struck by the resemblance of these bodies to the corpus luteum, and recently this comparison has found striking confirmation. Not a few operators I have observed find difficulty in reaching these bodies in dissecting. This should not be so, as it is a very simple matter to strip the peritoneum toward the midline after cutting it in a broad curved line made beyond the kidney.

Sometimes I bring the kidney and suprarenal body out together by gentle traction on this peritoneal flap, cutting the posterior attachments of both. The combined mass can then be easily dissected from the posterior aspect without injuring the blood-vessels.

The commonest change is increased firmness. This is usually associated with thinning and with softening of the middle, which is so easily broken as to give the impression of a cavity. Sometimes the body is thick, light colored, and soft. It is difficult at present to build up a list of pathologic conditions, but I have seen many suprarenals called normal at postmortems that I knew were diseased, but could give no satisfactory name to the condition found; nor could I indulge in such common platitudes as "cloudy swelling" to cover my ignorance. When we do receive a classification of abnormal conditions of these organs it will have to be based on their whole architecture as well as on their different component substances. I have seldom seen them affected by direct extension of inflammation.

Sometimes they are swollen and inflamed, rarely directly infected, sometimes cystic. Often one finds degeneration of one or more types. With our increasing knowledge of what have heretofore been called functional disorders will come a preparedness of mind to receive a rational classification of abnormalities of these bodies. Until these good times we must observe and dissect, and, above all, fracture these organs, for here, as elsewhere, fracture tells more than section.

DIGESTIVE SYSTEM

Nowhere in postmortem work am I more impressed with the habitual disregard of the fundamental principles of physiology than in the examination of the digestive system. Seldom if ever have I seen evidence that the operator considered the fragments as parts of a whole. All rules in the ordinary works tell how to cut and separate, to pull apart and tear down, but how much discussion does one find of how to mentally reconstruct the system?

I cannot conceive the art to be limited to simply the technic of dismemberment, regardless of the proper result of an examination, the conclusion as to the whole picture of the case. So entirely vicious do I consider this present habit—it does not deserve the term "method"—that I am tempted to discuss it fully and very freely. The advice I give is to forget it. I shall try to follow my own advice. Think rather of the skilled watchsmith and how he studies the parts in position before he dismembers the object of his art. His ideas all run along the lines of the machine in action, going and working perfectly; he has to discover all that was wrong, and why it did not continue to keep going right from key to hands. I often wonder why it is necessary to have any lower conception for the medical profession than we have for what we regard as inferior arts.

From the last cell in the brain, which plans to procure food, to the toes, which help to go after it, the human being is a feeding, and food-getting, and digesting mechanism. That he is more, should not divert our minds when we are discussing the digestive system. Every cell and every bit of cell product in the body tells of the working of this machine. What use is there in weighing and measuring and inspecting and handling the parts and the organs unless we gather something of an insight into the factors of nutrition? We cannot finish our study of these factors of nutrition unless we understand the condition of the whole digestive system. What use is it to discuss local disease findings unless we are wise about the conditions in which the disease developed? Even the narrow bacteriologist knows the folly of discussing cultures without considering the nutritive qualities of the media on which they grow.

The mechanical considerations of the digestive system, which include the whole of modern anatomy of the parts, form the insignificant minority of the subject. Even the chemistry, most of which is to be developed, leaves a vast portion of the field untouched.

Try to digest a square meal after learning of the death of a dear one or after great fatigue. Attempt to cure an indigestion with anatomic knowledge, or even with the aid of physiologic chemistry, and you will generally fail. Come to the postmortem room with only a knowl-

edge of anatomy and anatomic pathology and your gleanings will be pitiably useless. The utterly futile discussions of the present-day surgeons of the belly will some day be replaced by considerations of things as they are, and why should not the operator at the postmortem study all of what is before him and not simply bits of things? Instead of the present-day inspection, which reminds me of what I gather from looking through a Chinese book, let the operator read what is written in a book in a familiar language. That the language is not always easy to master I admit, but that is no excuse for descending to present methods of work. Let the completeness of the apparatus and the significance of the parts to the whole system be in the mind from the beginning to the end of the study. Let us not forget the relation of the nervous factors, anatomic, physiologic; yes, and even let the psychic be properly remembered, not simply when we cut a case of insanity following indigestion or of indigestion following insanity, but in all cases remember to read the signs of all the factors.

We know that indigestion often precedes nervous disorders, and very frequently follows them, but do we search the body for evidence of trophic changes before we finish our summing up of the condition of the digestive system?

I am utterly at variance with those who advocate thoughtlessness at the postmortem, and nowhere is it more generally seen than in the usual examination of the digestive system. Few, of course, proclaim their attitude in this matter, but they do advocate the reliance on a method which is born of disregard of the obvious, and leads to stupidly mechanical proceedings, wholly lacking in that insight which is the very essence of thoughtfulness. Being puzzled one day by the condition of the stomach, I proceeded to examine the nose. This caused great amazement and scorn in several wise persons who were present until I found a severe ozena, which explained the stomach findings. Yet these same persons would not have eaten a dinner prepared by a chef who suffered from anosmia, and they had often suffered all sorts of digestive perturbations because of colds in their valuable heads.

The condition of the **mouth** has been made the basis for two great groups of specialists, one elevated to the dignity of a separate profession, but the tongue has no longer the value as an index of digestion it once had, though what it tells to the trained observer is of the greatest possible value.

We still hear of the influence of bad *teeth*, because mechanical factors are easier to talk about than are the higher physiologic functions. I have a forgotten, highly heretic work before me which describes the **tongue** in a way that makes modern works seem very crude. For example, "a broad, pale tongue, coated at its base, . . . indicates an overloaded stomach; broad, pale, with a pasty white coat, needs an alkali; long, pointed, reddened, relieve irritation of the stomach; dry, contracted, slick, or covered with a dark coat, needs an acid." Here are four types clearly indicated which we see at postmortem, and the pictures are true and the significance clear. Science that ignores facts

ceases to be science. The tongue is one of the organs, generally ignored, which tells something that can be learned nowhere else, because it is absolutely in harmony with the digestive system, and its relation is highly purposeful in the plan of that system in action.

The **throat** is the common property of the digestive system and its daughter, the respiratory system, so that it must be given its double significance; its infections and sympathies relate to both.

The **esophagus** is far more often the seat of disturbance than is recognized. Little slime remains because of the powerful swallowing impulse, and the redness and swelling fade after death. What remains is to be magnified to get a true conception of what existed in life. Follicular esophagitis is very significant, and evidence of irritation by regurgitation of strongly acid gastric juice tells much of the habit of the stomach.

THE STOMACH

THE stomach is such a simple mechanism that it does not command its share of attention. The size, shape, and position of this organ are often the results of purely accidental factors, such as the amount of the contents, the condition of the intestines, the stage of digestion after a meal, the intra-abdominal tension. Hour-glass contractures result not rarely from irritation of a half-dead stomach by postmortem digestion at a point where the pure gastric juice floats on the edge of a mass of food, or from some other equally simple cause.

The **size** must always be considered with regard to the actual contents found as well as the probable contents at the time the stomach lost the power of contracting; added to these must always be the distention by gases of fermentation which are present or which have escaped or been absorbed. All these problems need a clear understanding of what takes place in and about a *stomach after death*.

Abdominal pressure may completely empty a stomach which was full at death. Though this is unusual in fresh bodies, it may be and is common where the contents were largely liquid or gaseous. Thus, after drowning free purging of water from the stomach, generally supposed to be coming from the lungs, is common. The amount and kind of handling which the body has been subjected to has not a little influence in this matter.

Fermentation with the production of gas is quite common, specially after ingestion of well-cooked starch, and may cause any degree of distention. The way the contents fill the lumen is quite as important as the actual size of that lumen.

Whether *digestion* proceeds *after death* depends on the amount and quality of the secretions present at death, and also, in an empty fasting stomach, on the amount of convertible preformed substances in the glands.

At times one finds there is practically no postmortem digestion, though a meal was eaten some time before death. At other times the stomach is so completely digested that one might suspect that some corrosive acid had been swallowed. This digestion may extend to adjacent organs, even to the lungs, through the diaphragm. The average case will give us a fairly accurate notion of the time the meal was eaten before death by regarding the amount of contents as well as the composition and the stage of digestion of the component parts of the meal, and not a little as to the sort of digestive power the particular stomach possessed. It must be remembered that masses of food of a nature to resist the action of gastric juice will generally show little change, though the contents are highly acid and the stomach walls show much diges-

tion. Such digestion of the walls may be mistaken for the effects of an irritant poison.

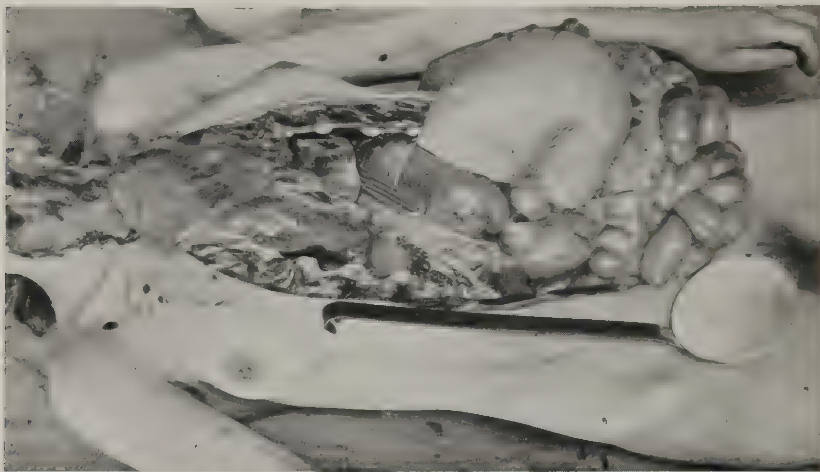


Fig. 198.—The stomach was distended with gas and popped out. Its shape, position and relation, and the distended duodenum are well shown. Note also the condition of the right lung.

Fig. 199.—The stomach has been punctured and now contains only a little fluid. Note the duodenum; the change of position of the liver; the size of the heart; the transverse colon. Note also the dipper, which is the most useful form for removing fluids from the cavities. The enameled measuring cup is also useful.

If there is little material in the stomach the effect is apt to be limited to that part of the stomach where the contents lie in contact with it,

but if severe gastritis existed one may find a layer of tenacious mucus poured out so as to prevent this contact, and part or all of the stomach may escape erosion.

The interpretation of the appearances in a stomach is far from being a simple matter, and these appearances vary more than in any other organ. Careless handling also has a very marked effect on these appearances. One can produce very striking effects by compressions, squeezings, and rubbings that will completely alter the appearance in certain cases. The interior and exterior must be compared with the

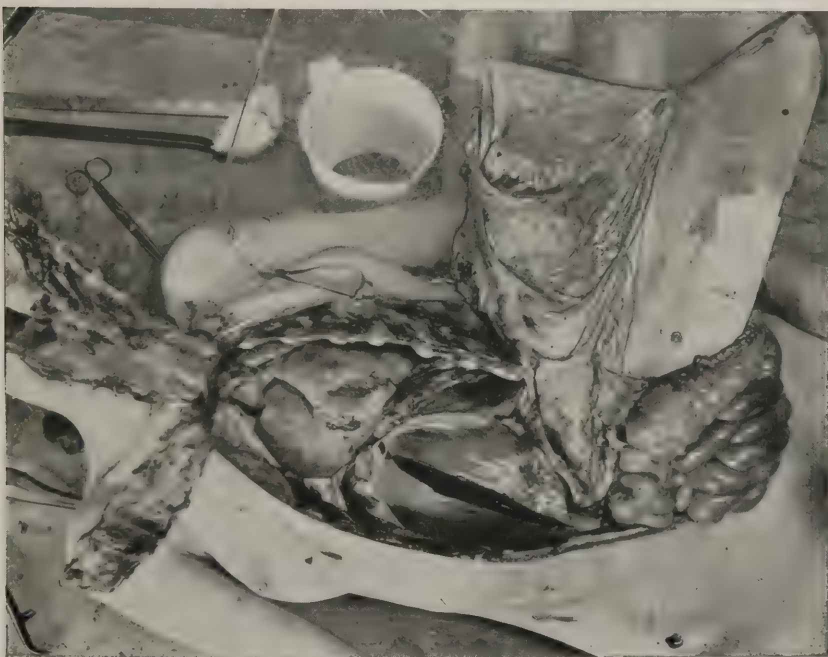


Fig. 200.—The stomach has been opened along the front and, by string, it is stretched over a glass plate. This gives an excellent opportunity to study it by reflected and transmitted light. The duodenum has also been opened. A strip of the chest wall has been cut away to show the enormous heart. The diaphragm has been opened in front to bare the liver. Note particularly the difference in that part of the liver above and that part below the edge of the sternal area. A cut in the liver indicates the best single cut to make. Note the thin, pale slime on stomach wall.

greatest care, and I find this can best be done before removing the organ by opening it from near the pyloric end, along the front surface, and looking through this opening before any serious handling has been indulged in. The condition of the walls can only be judged after noting the size and shape and contents.

The **odor of the contents** is always significant, not simply when some substance has been ingested which has a characteristic smell, but in all cases, for it tells much as to the habit of the organ in regard to quality, quantity, and rate of secretion and motility, and also as to de-

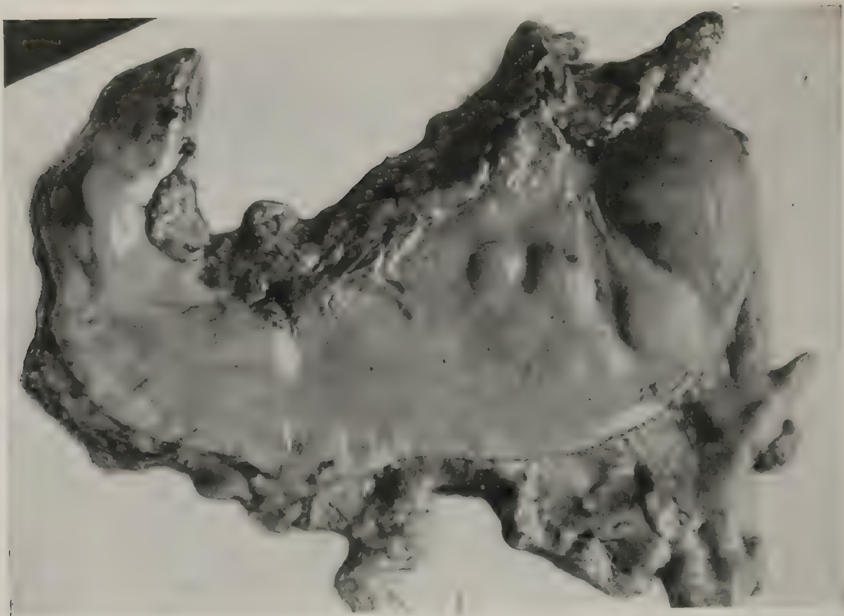


FIG. 201.

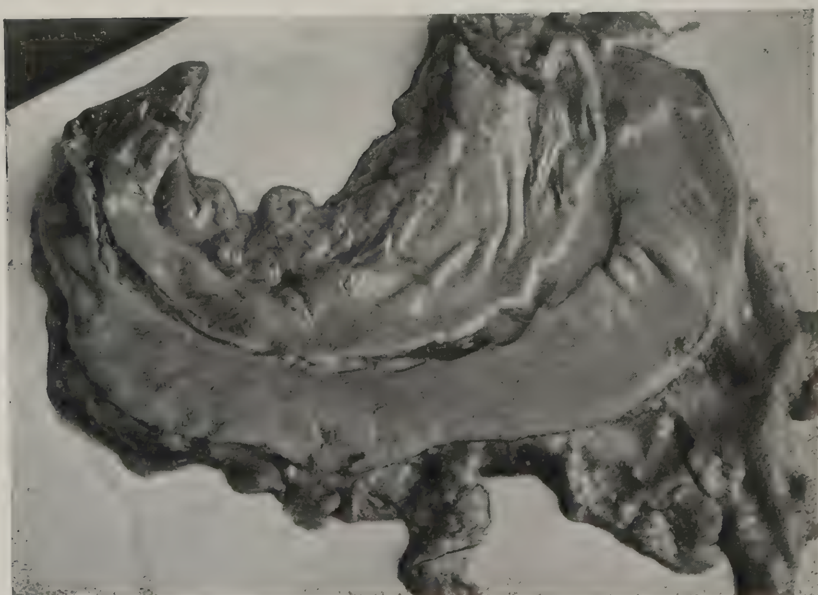


FIG. 202.

FIGS. 201, 202.—THESE FIGURES SHOW A STOMACH REMOVED WITH THE OMENTAL TISSUES ATTACHED.

The irregularity of the line of opening is intentionally made to allow of exact replacement of the edges. The cutting is done with scissors from the pylorus to the esophagus, along the front and not at the edge. The contents are observed as the cut is made. In this case there was only mucus and a little gas. The light frilling impairs the artistic quality of the figures, but in no way affects their value.

composition or fermentation. The odors of the substances ingested plus those of fermentation changes, taken with acidity and the peculiar natural or equally peculiar pathologic secretions, are often disagreeable but useful subjects for study.

The presence of *poisons*, whether taken as medicine or food or in quantities to be fatal, is a most difficult subject, which is briefly treated under the heading of Poisons. One must be on one's guard constantly to differentiate inflammations and postmortem changes from the effects of poisons, but must always remember that many poisons produce little direct effect on the stomach.

Congestions seldom appear after death as in life. The color of active arterial determination is almost always less after death, while

Fig. 203.—The fundus, at the right, which is much eroded by postmortem digestion, and was of a high pink color. In the middle are seen ridges and furrows where the free gastric juice has eroded down into the blood-vessels; the dark streaks were deep red. The lesser curvature is indicated by a ridge. On the left the slightly changed pyloric end. The organ was greatly dilated and showed signs of marked chronic gastritis. The hair is characteristic of gastritis in a far advanced stage.

passive venous congestion may diminish or increase. Generally, unless for some definite reason, it remains fairly constant.

The mucous membrane is so apt to be changed by postmortem digestion that great care must be exercised in drawing conclusions, and any evidence of slime must be most carefully studied, because such evidence is far more convincing than any subsequent histologic examination can be of the general antemortem condition. Maceration, while far less significant than digestion, should be remembered.

Hemorrhagic conditions are generally postmortem results produced by erosion down to and including the tips of the vessels, and these are greatly affected by handling.

Blood in the stomach generally comes from somewhere else, but should be traced to its source if possible. This is usually easy, but in some cases of stomach bleeding, specially in portal obstruction, it is difficult if not impossible to find the source.

Such blood generally shows by the nature of the clotting and by the differences in parts of the mass, as well as by the mixture with other substances, such as froth and stomach contents, whether it was from a slow or rapid hemorrhage, and often one can tell its age and source. It must be remembered that blood acts as an emetic at times.

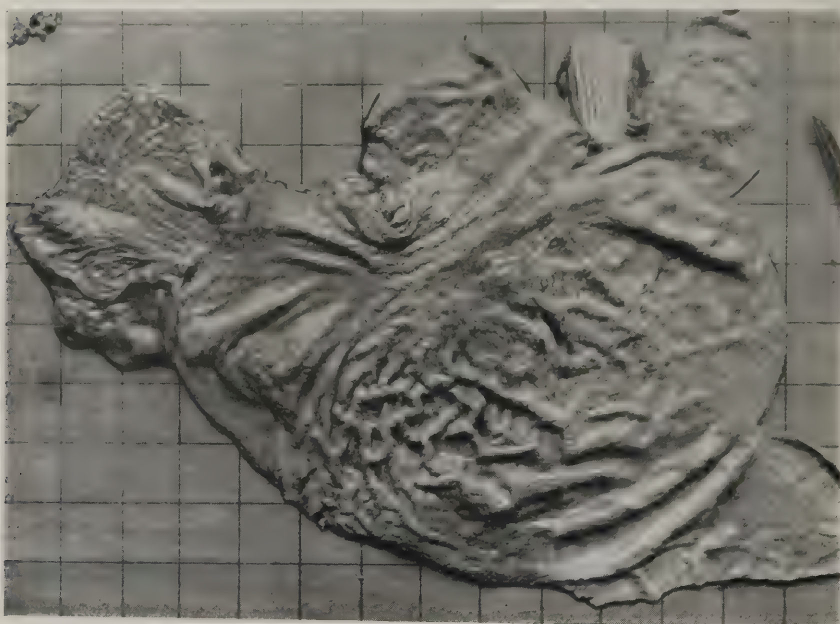


Fig. 204.—Stomach in Carbolic Acid Poisoning.

The stomach is opened along the front. The esophagus is quite white and ridged. The mass of the organ is irregularly folded. The walls are thick and hard. The surface is very rough and coagulated. A thin layer of whitish material covers an intensely colored base of dusky purple, shading to coffee-brown. The duodenum is only less affected than the stomach. A curved cut at the right end has been made to indicate the actual outline of the stomach before it was opened. The lesser curvature can be readily followed from the esophagus to the pylorus. The background is ruled in inch squares.

True **inflammations** are quite common and are generally limited to the mucous membranes. I have never seen an abscess of the wall, and seldom does one find the serous coat involved except where deep ulceration has extended or when serious peritonitis exists, and usually it is less marked on the stomach than elsewhere.

Infections of a catarrhal nature undoubtedly extend from the upper passages, but the normal acid reaction limits this generally to acidophilic forms. True non-germic irritations are common. The active congestion which is normal in powerful efforts to digest a full meal resemble inflammation, and in catarrhal conditions one finds the changed

secretions more abundant during this period. Their amount as well as significance should be considered, with regard to the secretory effort and stage of digestion reached.

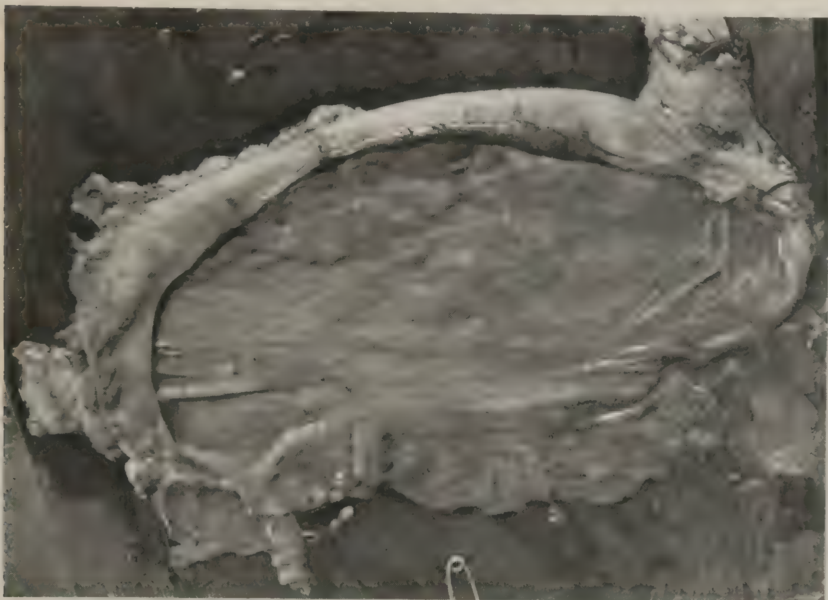


FIG. 205.—An intense gastritis with a lot of semifluid gelatinous mucus, the masses of which are lighter in color than the more fluid purulent part. A very interesting case occurring with peritonitis by extension from the pelvis, following a criminal abortion. The outer surface is seen to have been fairly normal.

Ulcers and tumors and other gross pathologic findings will, of course, be duly examined and their relations studied.

Gastroptosis generally implies some form of relaxation and often arises from a true fibrolysis, often increased by habitual distention, sometimes from mechanical causes, rarely as an anomaly.

DUODENUM

THE duodenum is at present the delight of the modern surgeon. I often wonder what would happen to the plumber if he forgot to consider the function of the pipes he coupled up as often as the surgeon does. Anatomically, this bit of tube is so simple that it is almost insignificant. Yet we not rarely forget that it is the only fixed part of the small gut, and we seldom stop to consider why it is fixed while both the stomach and adjoining bowel move freely, nor why it is not attached to the liver as it is to the pancreas, so that the common duct will not receive massage by pulling. On the other hand, this fixation is relative, for there is often quite free motion. But of greatest importance is the often neglected physiology, without which we cannot possibly comprehend the pathology of the part. The pylorus shuts not only the stomach against the exit of food, but also against the flow of acid into the duodenum. It further shuts the alkali of the duodenum from the stomach, but the presence of bile in the stomach often shows that there is a natural regurgitation at times, and it is well to truly grasp the significance of this alkali backflow and why and when it takes place. It is hard to see how a hyperacidity of the stomach could be met in any other way. An excessive acidity will surely start something unless neutralized.

There is something in the stomach which reflexly warns the pancreas to prepare for work, just as there is something in the mouth which warns the salivary glands of their duties. When we do not actually know we are forced to use reason, and it is reasonable to suppose that such a warning is started by chemical and mechanical stimuli, probably in no small measure by the acidity of the stomach contents. It is perfectly clear that the chemical factor in salivary secretion is very important, but we also know that chewing alone will start the flow. We also know that the sight of food or even the thought of it will make the mouth water. That these influences act on the pancreas we do not know, but the position of the parts strongly indicate that peristaltic action of the stomach very probably influences the pancreas. What starts the secretion of bile we can only guess at, but our anatomically insignificant duodenum very soon appears to be the focus of the most vital processes of digestion, and shows how insufficient is unaided anatomy for practical purposes.

But we have hardly made a beginning of the duodenum. From the stomach come jets of acrid acid stuff into a little tube that has been alkali before; there must be some very active reflexes calling for alkali help. If the duodenum is sore, these will be very loud and insistent, just as a sore mouth calls for saliva, and probably just the same way the answer comes.

If this soreness continues, the responding fluids will surely change in character, and these changes we find if we open the gut respectfully and intelligently, and avoid the utterly vile slop-bucket method of destroying the evidence of what has taken place. If the response is in excess of the needs of the duodenum we have hyperalkalinity. This also we find, though it has wonderfully escaped the attention of not a few writers—I do not say observers. All this call and response balancing varies in health and disease and with the amount and sort of food, and with the tone, power, and nervous backing of the stomach. This

FIG. 206.—The examination of the duodenum (*Du.*). The liver (*Lv.*) is turned up, the intestines down and to the left, the "indifferent" tissues cut through. The spleen (*Sn.*) laid out over the left side retracts the pancreas (*P.*). The stomach (*S.*), partly opened by an anterior window, is retracted quite forcibly upward and to the right. The large forceps raise the structure so that a straight probe passes through the common duct into that of the pancreas. (Compare with Figs. 98 and 198.)

little tube is just so curved that it must mix the component output from the stomach and the liver and the pancreas.

Now, when the surgeon chops the duodenum he sometimes ignores these simple little matters, which not infrequently is good for business, but very unpleasant for the patient. It is not an accident that acid and alkali meet and blend in the duodenum, and the pathologic findings will remain profound mysteries until this matter is understood.

The significance of hyperacidity and hypo-acidity is important enough in the matter of gastric digestion, but it has many other rela-

tions quite as significant. The effect on the duodenum is to be seen and not ignored. The disorders of liver and pancreas have a similar significance in the resulting changes wrought in the atmosphere in which the membrane lining the duodenum is to live.

Add to these conditions of chemical influence those of fermentation and infection of the food as affected by the variations of acidity of the stomach, both in quantity and rate of secretion, and we are forced to wonder that the duodenum is not in worse condition than we usually find it.

In fact, it is vastly worse than descriptions would lead us to believe in many cases. Noses stop up all around us from colds, but I have never heard a discussion of a cold in the duodenum in any medical society, yet I have frequently found unmistakable signs at the postmortem, and these alone can explain the symptoms we hear of in the very cases that we observe. Edema and congestion fade after death, leaving at most but a vestige and some relaxation of the formerly overstretched membrane, so we must wisely and carefully multiply our findings.

I always plan to approach the duodenum with gentleness and care because the contents are easily displaced, and when so displaced the story is lost; the opportunity to collect valuable evidence wasted. In poison cases I find it generally quite as instructive as the stomach, and try to avoid squeezing the stomach contents out into the gut for this reason more than all the others combined.

I have photographed the duodenum several times because I wished to show how it should be approached without crude violence. The evidence of chronic or very severe lesions may be discovered even by the careless methods usually employed, but how often does one meet with histories pointing to the duodenum and read in the protocol in vain for evidence that searching and care has been given to this part? That the duodenum is buried out of harm's way so as to escape violence and peritonitis is very significant. That it is fixed in the focus of the abdominal nerves and vessels is no less significant.

PANCREAS

I HAVE often asked why the pancreas was given so little attention at the postmortem, and the common answer was "What is the use?" If we only consider it anatomically and pathologically, the answer is entirely complete and final. I cannot bring myself down to that level. At the postmortem one constantly finds marked variations in size, consistency, color, texture, and total appearance, and with these variations one may find curiously related conditions of stomach or intestines and their contents. It is from the study of these relations that the operator should glean wisdom. If he has any mastery of the digestive focus—the duodenum, and its relations—he has some knowledge of pancreatic physiology. The reflexes which cause the congestion preceding active secretion in any gland must arise in certain organs according to the well-recognized laws of secretory action. Preparatory impulses must come from the stomach, and they must vary with the condition of that organ as well as with the exciting cause. In every case of hemorrhagic pancreatitis that I have examined I have found gastric irritation clearly marked, nor was I surprised to find it.

The relations with the liver are more obscure, and those with the intestines being still more complex, because they include the action of bile, stomach, and pancreas, must be difficult. Consider why the bile and pancreatic juice is poured into the duodenum through a common vent and one must concede that there is a reason.

When I find one of those cases where the ducts enter the duodenum separately I strive to obtain the history of the case with special relation to the whole digestive function. My own conclusion is that the pancreatic fluid varies as does the saliva under different stimuli, and that it not only dilutes but modifies the bile by its composition. I conceive the liver secretion to vary less. The mixture being better adapted to perform its duties in the very short mixing place allowed than if the two components struck the stomach end-product separately. The valve protecting the opening of the common duct is of great importance and its diseases are too often ignored. I find that the quality and size of the pancreas varies with the general nutrition of the body most markedly. Thus, a fat man's pancreas could not be mistaken for that from either a powerful laborer on one side, or from a thin, nervous clerk on the other. So also it varies with the time the digestive and nutritive habit has lasted.

Atrophic changes are very common. Fibrosis is frequent. The variations that are not strictly pathologic are vastly more instructive, as well as more common, than those which could properly be classed as pathologic. Problems of compensatory action arise where the liver function is greatly impaired, as well as in atrophic gastritis and, to a less

degree, of compensatory atrophy, where these organs have been over-developed during periods of overwork which have ceased by changes in living. The effect of alcoholic stimulation of stomach and duodenum is most interesting. Pancreatic engorgement appears in the acute stage and fibrosis in the chronic stage with singular regularity; so also one finds effects of other irritants in the stomach.

Tumors and infections of this organ are not very common, and fat necrosis in the belly is seldom overlooked, but the everyday things of real importance are too often neglected.

LIVER

Discharging into the duodenum with the pancreas and united with it in a way not altogether clear is the great metabolic modifier organ of the body—the liver. Why the liver stores glycogen, but does not appear to be related with diabetes, is suggestive. Add to this that the complemental organ, the pancreas, helps to digest carbohydrates, but when diseased, instead of finding less carbohydrates in the blood, we find more, and we begin to realize that there is a subtle balance maintained by these two. If it helps us to grasp this to use formulæ of speech we can speak learnedly of internal secretions, but at best they are products liberated under certain causes resident in the organs and acting on rather definite laws.

There is not space here to discuss even the little we know positively about these matters, but it does seem a pity that we should shut our eyes when we do a postmortem to these perfectly evident relationships, and wait for the proverbial forty years wandering in the wilderness, which seems the allotted time required before a new conception can attain entrance into the promised land of scientific credence.

The relationship of the liver is still wider.

When the outlet of the bile is obstructed the kidneys excrete it, and when the kidneys are blocked ammonia appears in the intestine, or we find some other form of nitrogen excretion. Often one sees a compensatory attempt on the part of the kidneys in atrophy of the liver. The cells of the liver are only slightly more differentiated than the spleen, and one would reasonably expect them to adjust themselves to a wide range of necessities. When the liver is atrophic the spleen is frequently enlarged, as if from compensatory hypertrophy. These varied chemical calls on the groups of slightly differentiated tissue are the only possible way the marvelous balances are maintained in the extremely complex nutrient fluids of the body. Some day, when internal secretions are better understood, we will wake up to the richness of thinking and observation in the old humoral philosophy. Though the language is apt to offend the highly ignorant devotee of modernism, certain it is that there are critical points not only for clotting of the fluids, but for each particular quality, which must be maintained with astonishing regularity, and that the regulator organs must work in close harmony is too obvious to be disputed by thinking persons.

It is clear that the liver is actually connected with digestion in a double way, from the anatomic evidence: through the bile going into the duodenum above, and the portal ciculation draining from below. It is also clear that the common duct for the bile and pancreatic secretion is no mere accident. Our simple chemical knowledge tells us of the

glycogenic functions of both liver and muscles. Our observations at the postmortem show a tendency to bulk compensation. We have seen the relationship of the liver mechanically to the diaphragm and mediastinum and to the function of respiration. Pathology and clinical experience have taught us the results of retention of the bile on the brain and the other organs.

Why is it necessary to forget all these things, even if we object to the injection of reasoning and thinking into necropsies? My main objec-

Fig. 207.—To determine the direction in which to cut, pass probes into the mouths of the vessels. Few are so familiar with the internal architecture of the liver that this will be undesirable or unnecessary. In dissection, follow the directions indicated, avoiding thoughtless slicing. This liver is clearly one of advanced interstitial hepatitis with beginning contraction of the fibrous skeleton. The shape is compressed or bunched and the mobility is greatly lessened, as well as the resiliency much changed. The gall-bladder is large and corresponds with other indications that the secretion has not begun to be seriously diminished. (Compare with Fig. 208.)

tion to the use of words ending in *opsy* is that they too truly express the usurpation of the bodily eye when the mind should also have a share. The liver is far too important an organ to be thus relegated to the classic methods of neglect. Its conditions in every particular are before us at the postmortem to be studied.

I have purposely not taken photographs of this or any other organ being sliced, after the art of the butcher. Should anyone wish to learn that art, let him observe a skilful butcher work; he will find it much better practised than in most postmortem rooms. It is, I admit, useful

at times, but it has always semed a pity to descend to the level of the butcher's trade and still clamor about science. The size, shape, and consistency of the liver are all very good as a beginning, and the histologic shavings are at times very valuable, but how much more that is wonderful, interesting, worth while, and practical lies before us when we open the body and begin to study relationships of the vital organs, and of the adjustments so easily observed and so often overlooked.

FIG. 208.—The vena cava and its branches opened as directed in connection with Fig. 207. It will be seen that by this method one can more readily follow out the branches, even when cut in opening up the larger ones. This liver is of an entirely different type from Fig. 207. It is highly mobile, of high color, low fibrin content, and is clearly undergoing chronic parenchymatous change with secondary change in amount and consistency of bile, and the condition of the gall-bladder shows already a thick wall and small contents. Note also the contrast between the texture of the vena cava in the two cases.

Is it possible for us to understand the problems of disharmony in the body, which we call disease, dyscrasia, idiosyncrasy, unless we begin in a rational way at the fundamental factors?

The liver is the focus of these visceral functions, and its pathology is only significant as it is a modified normal actor in relation to these fundamental factors.

PATHOLOGIC CHANGES

The liver is peculiarly liable to pathologic changes:

I. By reason of chemicals (*a*) taken up by the portal vessels.
(*b*) From abnormal products of digestion.
(*c*) Toxins from putrefaction in the gut.

II. Infections (*a*) passing through the portal vessels, gathered from the gut.
(*b*) General infections circulating in the systemic vessels.
(*c*) By extension from the duodenum along the bile channels.
(*d*) By direct extension from the peritoneum.

III. As a result of disturbances in other organs, whereby its functions are deranged or overtaxed and secondary structural changes follow.

IV. Circulatory changes due to vascular disease or heart affections.

V. Mechanical effects, such as compression, bending, and variations in normal massage, interfering with size, shape, circulation, and the flow of the bile.

VI. Tumors, growths; deposits from general diseases; secondary forms of a large variety.

The **condition of the substance** of the liver determines its appearance and consistency. The significance of any single peculiarity can be best arrived at only after a review of all, and can be comprehended only after completing the postmortem.

The **size** may vary with the amount of work to be done, which will not be the same for all bodies of the same weight.

It may vary with the deposits, normal or pathologic; or from atrophy or by congestion, hyperplasia, inflammation, or tumor.

The **shape** may vary because of relations with the place it has to occupy.

On account of hypertrophy or atrophy or deposits it thickens or thins eccentrically—that is, in so changing in volume it is apt to vary in shape and not simply increase or diminish as a result of inflammations and secondary processes.

Its **color** varies from the normal brownish hue in both directions toward a darker and toward a lighter one. With this its blood content adds a red factor, which varies independently. All irregularities of color distribution are significant, whether diffuse mottlings or local, about bile or blood-vessels or in patches.

Its **consistency** varies very greatly in many ways: one group shows softenings of different kinds; another, hardenings; still another shows changes of elasticity. These may occur together, certain structural elements concentrating, others softening at the same time.

The **fracture** of this organ is generally more significant than the surface of a clean-cut section, and tells us more at a glance than can be gained in any other way. Sometimes it breaks like granular butter,

while at other times it is so firmly fibrous as to be torn only with the greatest difficulty. This fracturing and the study of the fractured surfaces, taken with the other characteristics, tell us of the amount and advancement of the changes and of their distribution.

The differences between acute and chronic processes are most marked, and even where an acute hepatitis has been added to a chronic one the peculiarities of each appear, but modify each other. In one case the tiny granular tufts will project from their fibrous setting, while in another the tearing of the fibrous network will almost reduce the parenchyma to a pulp; in still another type the parenchyma will appear scanty and

Fig. 209.—A small liver with marked parenchymatous change. On the left is seen a section, which shows little; on the right a fracture, which shows much. Note the texture of the surface and the way the tissue has broken away from the great vessel. The large gall-bladder was packed full of stones and contained no bile. Note the peculiar mottling in the lower right, and compare this with the grain of the cut and fracture surfaces.

cling in irregular fragments to the skeleton even when there is no true fibrosis.

The **capsule** may be changed by a true perihepatitis, but generally it helps us to judge of the fibrous skeleton, much as in the kidney. Normally it is thin, transparent, and inconspicuous, but in extreme cases it may be even leathery, or so intimately bound to the fibrous skeleton as to be inseparable.

The **vessels** vary in two important ways; with those outside, showing that the cause is a general one affecting all vessels; apart from those outside, showing a chemical or inflammatory condition within the organ itself.

The **bile-ducts** may be irritated or show reaction to more or less chronic irritation by changed bile or by hypersensitiveness on their part, or they may be affected by obstruction which may cause distention or irritation from the constant action of the bile, or they may show evidence of infection which generally comes from the duodenum, but not always. Deposits of bile-pigments are always significant.

The **ligaments** vary with the other fiber-containing structures of the body, and if they vary with the fibrosis in the liver the conclusions are

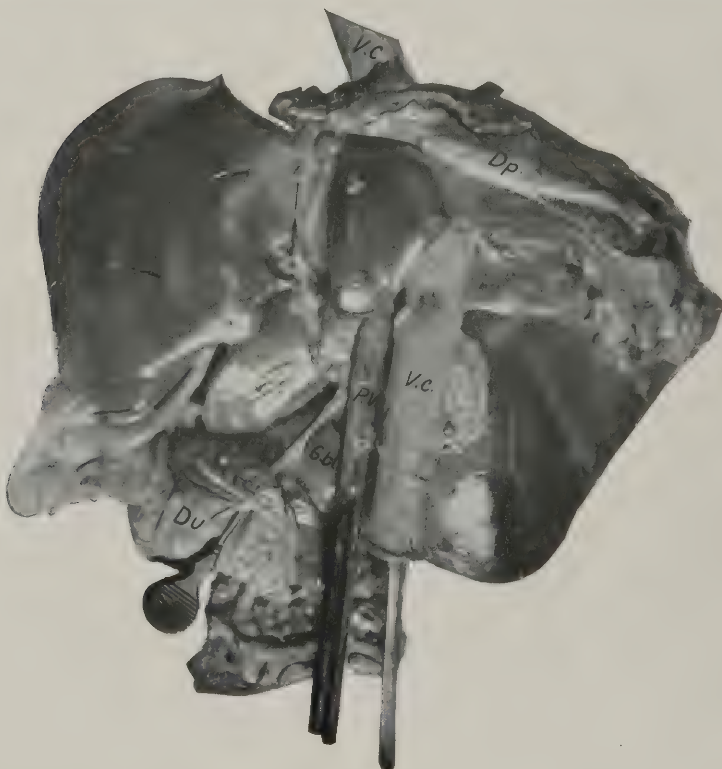


Fig. 210.—Under Surface of the Liver (Normal). (Compare with Fig. 211.)
G.Bl. Gall-bladder. *Dp.* Diaphragm. *Du.* Duodenum opened and probe passing into the common duct. *P.V.* Portal vein distended slightly by two knitting needles. *V.C.* Ascending vena cava distended by two test-tubes, one passed from above and one from below. (The glass rod being simply to hold the vessel in approximately its normal relations.)

entirely different from when they vary differently from the internal fibrous structure.

The **gall-bladder** is generally translucent, very flexible, thin, and contains a moderate amount of greenish, moderately viscid bile. It may distend or contract; it seldom is thinner, but often thicker, than normal. The contents tell of chronic and acute changes in the functioning of the liver cells just as the discharges from the mucous membranes tell what

has taken place in the cells. The variations in viscosity are great both by increase and by decrease, and the color varies generally toward red or yellow, a red color generally signifying true hepatitis, while a yellow often means secondary change in the bile. Concretions are only evidence of extreme or long-standing variations.

The **gall-ducts** may show any degree of change due to irritation, inflammation, or infection; may be contracted, thickened, or dilated. They must be studied in relation to the duodenum on one side and the liver on the other. Care should be exercised not to open the

FIG. 211.—Compare with Fig. 210. The Spigelian lobe (*Spg.*) has been cut away. The vena cava (*V.C.*) opened and glass rods introduced in the branches to show their direction. The lower test-tube is still attached to the lower end of the vessel, which is slightly drawn by the weight of the portion of the Spigelian lobe. The portal vein has been opened and the probes pass into the branches entering the liver substance, and show the direction of these branches.

ducts and bladder until other examinations are completed, because the bile is difficult to remove without changing the appearance of the parts and it stains dead tissues easily. When a sample of bile is needed for comparison with the intestinal contents gentle pressure on the gall-bladder may generally be permitted, to secure a drop at the opening of the duct in the duodenum.

Tumors of the liver are fairly common, and their relations must be studied carefully.

We cannot ignore the problems of age in relation to liver conditions. In children at birth the liver is very large and subject to certain grave

disorders. During childhood nose and throat infections and gastritis are very common, but the stomach is generally quite acid and liver disease is rare. In later life, when throat and nose affections are markedly less, and the type of gastric disorders change, with not infrequently a marked change in the amount of acid in the gastric output, we find liver disorders growing in frequency and increasing in variety. Red bile is far more significant in children than in old persons. Just what constitutes senility in the liver has perhaps not been properly determined, but the problem is well worth considering. So it would be well to discuss more fully the types of hepatic conditions that belong with the various serious general diseases. I am convinced that much of the cirrhosis that is attributed to alcoholism is chiefly due to enteritis, because I often find soft normal livers in drinkers and hard ones in abstainers, and even in drinkers one finds primary enteritis when the liver is hard.

INTESTINES

The general topography (geography) of the abdominal contents being kept in mind as described previously. The distribution of the blood in the different parts of these organs having been compared with the general distribution in the body, both as to amount and vascular variations. The intra-abdominal pressure having been in a general way perceived and estimated. The amount and distribution of the contents of the gut, as well as the general nature as to fluid, solid, or gas, and whether this distribution informs us of any motor peculiarity. The postmortem condition, that is, the degree and kind of changes that have occurred after death. The evidence of nutritional type of the body, with any peculiarity which will help us to understand better what sort of work has been done by the gut, this to include muscles, fibrous structures, fat deposits, skin color and texture, facial expression, quality and quantity of the hair, and nails. Tone indication in stomach, liver, and pancreas, and the condition of the mouth and teeth. These relevant, important, and not infrequently neglected preliminaries having been settled, we are ready to attack the problems presented by the special findings in the intestines.

Such extensive preparation is not usually advocated, but no earnest, intelligent person, properly trained in the methods and contents of modern science, wishes to fall into the dreary and futile methods so commonly to be encountered in books and journals, and at meetings where a complex apparatus is explained on the basis of a very fragmentary knowledge of some minor part. Purely anatomic discussions, such as are too often indulged in by surgeons, lead to ephemeral theories and quickly to be rejected operations.

Discussions based wholly on pathologic findings are even less satisfactory because, in the first place, the percentage of abnormal findings to normal is so low in the average case that we are only considering the merest fragments of the problems presented. In the second place, we can only be sure what is pathologic after we have arrived at a true conception of the physiologic type. Bacteriologic considerations are seldom satisfactory because we know so little of the normal variations of the flora of the gut and still less of its significance.

The intestines must also furnish us with evidence of the physiologic activities of the related organs and structures. Here too often we find the conceptions are fragmentary. One is regaled with long and wholly incomplete discussions of the sympathetic versus vagus influences, or with effects of drugs as studied by some minor signs or symptoms produced in unknown types of cases, the total effect of the drugs being wholly ignored. Wherever a recent series of experiments has been published we find the tendency to become forgetful of all but a very

limited phase. The modern method of intensively working up series of cases to bolster up a theory is not wholly vicious, but if your motor stops on the road you will find it of much more use to have a full and complete understanding of the principles of the working of its parts

FIG. 212.—The mass is seen laid to the right. With this view one can take in at a glance the condition of every bit of the gut, from the duodenum above to the last bit of the ileum. The condition of the vessels and lymph-glands; the attachment to the spine; the amount and distribution of the contents, and the general condition of the parts. Note the semicontracted state, the thickness of the walls, the reticulation of injected vessels in the left or shaded part of the mesentery; also certain projecting glands. A case of marked auto-intoxication from congenital malnutrition. (Compare with Figs. 82 to 100.)

than to have any number of thoroughly worked-up series of cases where the motor stopped from this or that or the other cause. The wise mechanic builds up a common-sense knowledge of the working of his machine, which he will not set aside carelessly because some one has advanced a new theory of carbureters.

We are seriously threatened in these days of intensive specialization with a total loss of power to think of things as a whole, and nowhere more than in the matter of the study of the intestines. Volume after volume on postmortems give us the routine method of cutting loose the gut; paper after paper shows that the routine method has been followed until one despairs of ever again seeing the common-sense method of studying the gut brought back into use.

One should be able at a glance to tell that a strong cathartic has been administered some time before death. Time after time I have asked the physician what cathartic he used after looking over the bowel in position. Had I ignored this my whole interpretation of the condition of the findings would have been clouded with a serious error. So with foods, condiments, and common drugs, such as acetic acid, soda, iodids, quinin. Each adds its factor in causing the appearance found in the gut, and if the contents are washed out before the examination is made the increase in errors of interpretation is enormous.

We must learn to distinguish the difference between congestion due to active digestion (determination), that of passive venous stasis, and active irritation. We must recognize the phases of digestion in regard to the filling of the chyle vessels. Nor are we to confuse a normally contracted empty gut with an abnormally small one with a thick wall. I have seen a contracture clearly due to some local irritant, acting after death, and before complete molecular death of the gut, mistaken for a constriction, even though the blood-vessels were bent and the serous coat was wrinkled, just as I have seen an hour-glass stomach diagnosed where a similar local spasm resulted from mucous membrane erosion by powerful postmortem digestion. Local changes after death are constantly mistaken for antemortem conditions, and the relations having been destroyed and the contents removed, it was not easy to settle the matter conclusively; on the other hand, where the determining evidence is present, there is no excuse for such bungling.

What is normal for the particular gut we are examining is not to be determined by any average of all guts not pathologic. Nor are we able to say what is normal with any assurance unless we understand the type of the individual in which the gut was working. The gut varies with age, sex, and type; it is perfectly easy to see from the illustrations in this book which are in old and which in young cases, even though they are seriously abnormal from disease. To regard the intestine of a powerful laborer, who used rough food in large quantities, in the same way one would that of a little female doll is the height of absurdity. (See Figs. 165, 194.)

One must try to gage the digestive caliber of the individual, modify this by the habits of eating as shown by the contents of stomach and bowel, consider the age and sex, and then, after noting the fluidity, odor, and consistency of the contents, begin to consider pathologic factors.

Throughout the whole study the condition of the contents is of the utmost importance. There are several types of secretion which are more or less common to all mucous membranes:

(1) The limpid watery discharge of ordinary secretion and moderate irritation.

(2) The viscid discharge of intense secretion, whether normally aroused or resulting from irritation.

(3) The tenacious turbid slime of irritation which one finds after some time, such as one finds in the nose after some days' duration of a cold in the head.

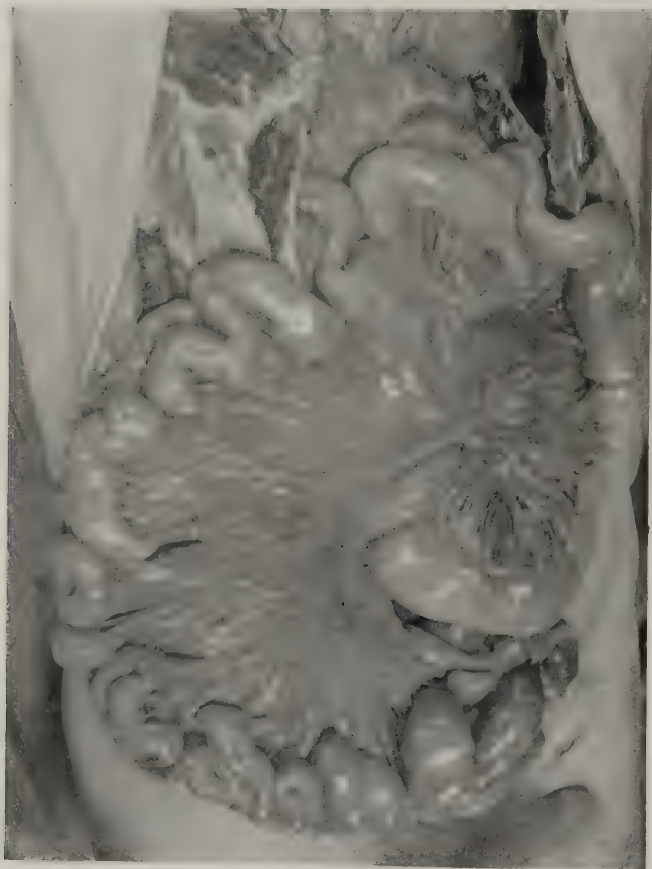


Fig. 213.—Examination of the Intestines.

Note the perfect view of the relationship of gut to the mesentery and its contained structures. The whole bowel is seen to have a very thick wall and the vessels of the mesentery are very prominent. There are but few lymph-glands and these are small, showing the absence of serious infection. The case was one of long-standing digestive disorder extending from the stomach. This type of gut is sure to develop atheromatous arteries. The contents were characteristic of old catarrh of the bowel, without large bacterial component. (Compare with Fig. 197.)

(4) A yellowish, mucopurulent, viscid discharge of late development after considerable irritation.

(5) A gelatinous, more or less clear, and tinted discharge, which almost always indicates severe irritation in a fairly early stage.

(6) Secondary discharges, serum, lymph, blood, pus; desquamation, slough, and pseudomembrane.

(7) Simple protective slime produced in limited amount to cover a sore area.

These may be present in different locations in the same gut, and may pass from one to the other or be widely separated. The distribution and degree of each area, both of production and lodgment, must be carefully judged.

Fig. 214.—Compare with Fig. 213. Same case. The increased contrast obtained by different technic brings out the injection of the surface vessels. Here the gut has been laid down and the other surface of the mesentery is shown; the large contained vessels are more noticeable. The rough, firm, high-colored liver and the dark granular and pitted kidney, which has been raised and the capsule removed, show the sequence of enteritis and toxic hepatitis and nephritis. The relative values of these two photographs can be judged by comparing the chest wall muscles which appear in both.

It is not rare to find a gelatinous, pale, straw-colored coating in the duodenum and a free slime lower down when the gastric product has been irritating. This may fade before the middle of the intestine is reached. Poisons of an irritant sort irritate only as far as they reach in a concentrated form. On the other hand, bacterial irritation is usually seen below the middle unless the stomach is also affected, and the increase of intensity progresses as we go down, and the mesenteric glands help us wonderfully to discriminate the type and distribution of the condition. The changes in fluidity, viscidity, and putrefaction are to be noted, because a change in either, which is not to be expected at the

particular level in the gut, is important. Far too seldom do we realize what is perhaps an offensive, certainly an unpleasant, thought, that animals as well as plants are nourished by manure, and the formation of that substance from clean foods is part of the function of the gut. The newborn infant alone has a sterile gut.

Unfortunately, we know but little about the significance of the flora of the bowel, but we do know that few foods or the products resulting from the action of the digestive enzymes are fit to be directly absorbed into the blood, and many of the nitrogenous bodies are actively poisonous if injected into the blood directly.

We can gain a little insight into the gut if we remember that fats, sugar, and water are the least altered, and that in fat persons we would expect full fat digestion with fewer of the toxic albuminous bodies and a less powerful manure production than in the normal, while in nerve workers and those whose nervous system is disturbed we expect to find the reverse.

With these two great types we usually find hyperalkalinity in the fat and hyperacidity in the nervous type. Glands in the mesenteries are less common in the fat than in the nervous, though scrofula is common enough and other glands are frequently affected.

Catarrhal conditions of more or less severity are very common, and, as already pointed out, their location, extent, degree, and relation are most significant. These may reach such a degree as to be recognized by the routine method of autopsy proceedings. One seldom finds a wholly normal or a wholly abnormal gut, because death would ensue before a wholly abnormal one could be produced. It is, therefore, of vital importance, if we are to even approximate the truth in our study, that we learn the significance of each variation that we find. To do this the anatomy, while necessary, carries us but a very short way in our work. The pathology is generally an insignificant factor. The bacteriology of the gut also adds a little. The chemistry of the gut secretions carries us still further, but, if we are to arrive, we must add a large measure of true biologic physiology which will help us to understand how reactions arise, and in turn cause other reactions, and how influences external to the gut produce definite or vague results as the case varies.

Serious infections along the alimentary tract not infrequently begin in the mouth, and then, as they become acclimated to the host, produce more or less systemic effect and more or less directly influence the nervous mechanism of digestion. Occasionally they spread to the structures of the neck and cause still further damage. The specific organism may be passed on in more or less tenacious mucus which will resist the action of the acid of the stomach, but will be acted on by the alkaline solutions in the bowel. However they may happen to get through the stomach, it is clear that they do so and not rarely. Many of the disorders of the epidemic type show very marked enteric effects. Certain special forms of local manifestation of infection are well known and easily recognized. These belong to the tubercular and typhoid groups generally, though certain other forms are not rare. These are well

discussed in the pathologies, but one must be on the alert for the common types which have not yet been sorted out. Thus, in one epidemic of cerebrospinal meningitis all the cases showed marked enteric involvement.

Effect of Drugs.—Drugs give a wide range of effects which are not put down in the works on therapeutics or clinical medicine; in fact, I find it rather hard to find them well discussed anywhere. Only in the field of toxicology does one find a reasonable effort at a description of the postmortem findings after the ingestion of drugs in the human being, and much of this is too crude to be of value. The field is too large and difficult to be more than indicated in such a work as the present one.

A brief synopsis of the **types** may be of use:

(1) Mechanically acting, including those acting on the exterior as simple solvents, water abstracting (osmotic), abrasive, corrosive.

(2) Soluble substances acting differently as the concentration varies.

(3) Slightly soluble and only poisonous as changed to a soluble form.

(4) Insoluble, so far as known, but poisonous.

(5) Those not entering the substance of the body, but acting usually as irritants locally.

(6) Those entering either blood, lymph, or cells.

(7) Selective, acting on special tissues.

(8) Excreted locally after absorption anywhere.

(9) Changed to active form locally.

A brief synopsis of **effects** which may be found will be at least suggestive:

(1) Vascular changes; pallor, redness—congestions, either passive or active—swelling with edema, congestion or inflammation, possibly with hemorrhage.

(2) Secretory change; increase or decrease of amount, change in quality, even to the markedly abnormal.

(3) Erosion or such irritation as to give more than vascular signs of inflammation.

(4) Dehydration from concentrated solutions of salts, usually accompanied with more or less increase of secretion.

(5) Evidence of the actual presence of the drug in mass or by color, odor, or reaction.

(6) Local contraction or relaxation of the muscular elements aside from those contained in the blood-vessels.

(7) Changes in the contents due to direct or indirect reaction on the various substances; these are usually noted as color, coagulation or precipitation.

(8) Changes produced in other organs, with or without local signs in the gut.

The **mucous membrane** appears thick or thin when no change actually exists, except that due to muscular contraction or relaxation of the walls. I have seen this contraction lead to not a few wrong estimates, even by the histologists. There are many modifications of the

component parts of the gut, including the glands. Some of these appear to the naked eye as changes of color, texture, consistence, and inequalities.

Glandular increase is fairly common, and may appear as follicular enteritis at any point, though more generally this is noted at the upper or lower end. The large, flat lymphoid masses called Peyer's patches appear usually in the lower half of the small intestine. Any further departure from the normal, such as swelling, ulceration, or pseudomembrane, will demand careful consideration from the point of view of pathology.

The **serous coat** may be affected by extension from inside or from secondary deposit along blood or lymph channels, but is more apt to share the condition of the rest of the peritoneum. Such effects are studied with the cause.

CONTENTS

The contents, as has already been pointed out, are of immediate as well as remote significance. Their study may be considered in several natural groupings as material, and changes:

(1) **Food.**—This enters the duodenum more or less pulverized, macerated, digested, and mixed with various secretions, from the stomach. In passing along it should undergo a rather definite amount of digestion, which will cause a loss of the character by which it can be recognized. There will be certain substances from the food which resist digestion found far down the canal. One should learn to recognize the degree of digestive progress of resistant substances as well as of ordinary foods. This will be greatly helped by recourse to the microscope and a few chemical tests.

Food carried beyond its proper area is to be studied and accounted for, and it must be determined whether there is secretory atony, muscular irritability, or true diarrhea. The best way to examine such food masses is to place in clear water and gently agitate, noting the sort of cloud caused in the water, the presence of adhering mucus, and the various changes in the food itself; portions can be squeezed between glass slides and highly magnified.

(2) **Bile** is almost always present in the contents. When it is absent there is a very striking gray color which has unfortunately been called clay colored, though the vast majority of clay, in this country at least, is yellow. The color of the bile in the gall-bladder should be noted as a standard of comparison because it varies very greatly, and it would be misleading to judge regarding the bile in the gut without first recognizing that it was seriously changed in color and consistency before leaving the liver. It is safe to say that green bile is not produced by any action in the intestine out of yellow bile, so that green bile below and yellow higher up should be a warning of sudden change of the secretion; such is, however, rare. The color may change slightly during the progress through the gut, but the greatest difference will depend on the rate of outpouring of bile at certain periods of digestion and fasting.

It should be remembered that the bile stains the tissues rapidly after they cease to live. This should not be confounded with a green color due to decomposition of the blood in the walls. Bile seldom mixes freely with the mucus from the intestinal wall, but may contain an excess of mucus before it enters the gut.

(3) The **color** of the contents depends largely on the bile, but many foods and drugs cause a marked change which one should always think of, such as vegetable colors and metallic sulphids. The presence of *blood* is detected by the eye chiefly by the different colors it may present. Fresh blood will vary from bright to nearly black red, but blood is usually quickly acted on by the secretions present; the colors produced vary from chocolate to coffee-brown, but if the secretions are scanty or the blood very abundant the color is scarcely changed, or may simply become very dark and tarry, or it may simply undergo decomposition. The place from which such blood came may often be determined by the position in which it is found, but it should not be forgotten that when the hemorrhage or supply is stopped the gut tends to clear itself of such blood, and if the point of supply is known we can estimate the probable time of the stopping and the onset of the hemorrhage by the position in which the blood is found. Other changes of color may arise from abnormal conditions which will need specially careful study in each case. The color of the gut and contents is very apt to be grayish in chronic kidney disease.

(4) The **consistency** varies with the sort of food, the amount and nature of the secretions, and the sort of putrefaction going on, as well as the amount of absorption. Gas fermentation usually occurs with carbohydrate food that is long retained, or is due to excessive fermentation, and may be of considerable significance. Gases of putrefaction, however, form when little or no carbohydrates are present.

The changes of secretion have already been spoken of, but, in addition, one must note the relative amount of each kind present and the way it is mixed with the other contents. When the contents are hard one can usually tease them out in an excess of water. I have seen inexperienced persons who did not realize the error of considering milk a liquid food blunder most amusingly over the presence of massive curds in the gut. It is well to remember what can happen to food, and then, by noting what has happened, one can draw definite conclusions as to the secretory as well as motor power of the organs. One often finds a peculiar slime, which I call "postdigestive secretion," in a gut that has recently finished working, and this usually differs from that found in the resting gut or in starvation.

(5) The **odor** of the gut varies even more than the color and is instructive. Certain odors attach to kidney disease, certain others to auto-intoxication, and still others to separate diseases, but until we have some standard by which to compare odors as we have colors it will be extremely difficult to express these peculiar types so as to convey definite ideas.

It must be remembered that the nose fatigues very quickly for certain

odors, so that one must plan to have his nose in condition, and must not expect to be able to detect odors after the sense has been blunted. This in no way interferes with the ability to continue to smell certain other odors for which the nose retains a painful sensitiveness.

(6) Related to odor very closely is the **bacterial** content. Unfortunately, our knowledge of the flora of the body is extremely crude. We must do the best we can to interpret the appearance, consistence, and odor of the contents and the reaction of the walls, as well as the involvement of the associated glands, and at times the condition of the other organs, which have to suffer from absorbed bacterial products and poisons, to help us measure the bacterial development.

COLON

The colon as a part of the intestines shares in most that has been said about them and offers some problems all its own. It is more apt to show peculiarities of position and support, which depend in part on the habitual action of the organ itself and in part on congenital or developmental peculiarity, and to a considerable degree on those secondary matters of general nutrition which affect all the supporting structures.

It is also subject to various inflammatory or toxic affections which we call colitis. Generally it is a simple matter to solve the problems presented, but not rarely there remains a considerable margin of the unaccountable.

Follicular, catarrhal, and ulcerative conditions are far from rare, and so far as possible the causes and effects should be thought out. The effects of bacterial action are very often to be noted, both those produced directly and also from toxic substances developed. Passive congestions, relaxed walls, diverticulitis are common enough to be profitably studied in their larger relations. Few poisons directly reach this part, but some are secreted by the gut and may cause local signs. Ergot and aloes seem to directly affect the organ.

APPENDIX

The appendix has undoubtedly received its full share of attention in recent years. Still it is well to remember that its diseases seldom develop without cause.

Among such causes we must count such general conditions as reduce resistance to bacterial invasion and such local causes as produce inflammation. In order to properly interpret the effects on the general health of an appendicitis one must, if possible, determine the duration, severity, and general history of the disease as shown by the condition of the part as found. To this end, scars, eroded areas, thickenings, adhesions, glandular involvements, and the condition of the adjacent parts of the gut are all of the greatest importance. What is found within the lumen may be of value, but is often of vague significance. With the return of a more thoughtful or philosophic fashion we may look for much valuable insight into the type of the individual to be gained from the observation of the peculiarities of the appendix.

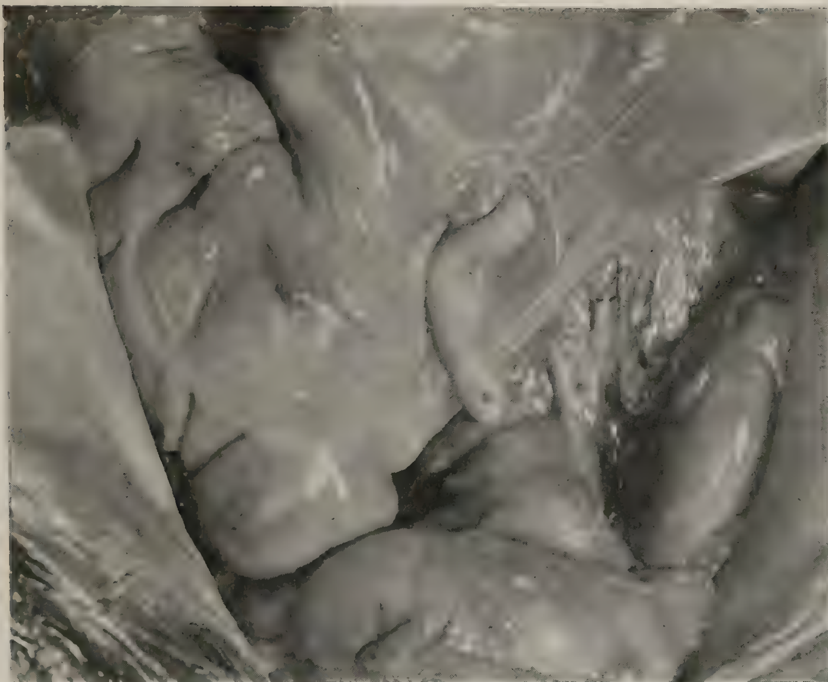


FIG. 215.—THE MALE PELVIS AND THE APPENDIX.

The small gut has been lifted upward. Note the network of blood-vessels in the head of the colon; also the peculiar mesh of fibrous bands about the window through the appendix presents.

RECTUM

The rectum receives such an overwhelming mass of bacteria and bacterial poisons, the wonder is that it is not more often seriously diseased.

The general conception regarding varicose conditions about the pelvis, and specially in the rectum, needs to be greatly changed if reasonably intelligent conclusions are to be drawn. The toxic factor is often forgotten, while the venous obstruction is generally greatly overestimated. Strange misconceptions prevail as to the relaxation of the sphincter at death. Rarely does one find the aperture open, and only when some definite cause has acted. So also the discharge from the bowel or postmortem purging only occurs for some definite reason and not as a routine proceeding. When the gases of decomposition accumulate in the belly, and the fixation spasm, which is normal for the anus and which passes into rigor without any actual opening, has disappeared, there is little resistance to the protrusion of the bowel contents. The death of the sphincter abolishes its force, but does not cause it to change its position, and at times its normal tonic spasm passes directly into rigor.

THE URINARY SYSTEM

THE KIDNEYS

This intensely significant little group of organs consists of a pair of the most compact chemical plants known. The chemical engineer who could imitate one kidney would require a ten-acre lot for his workshop. The inspection of such a condensed apparatus demands the aid of the microscope: first, for the formation of a mental conception of the structure, and incidentally to teach the pathologic variations, but the gap between biologic chemistry and histology is hardly less than that between mentality and brain histology.

There is little use in pretending to examine a kidney unless one first prepares a clear mental picture of the factors of urine production. One simply must understand osmosis, partial pressures, secretion, excretion, and the mechanical problems of the machine in which the work is done. One must know what osmosis is not and cannot be or one will fall into the common errors regarding the passage of solutions against the law of partial pressures. It is just as important to know what the kidney may do under unusual conditions as what it does normally. Our knowledge of the kidney will depend on toxicology just as truly as our knowledge of toxicology will depend on nephrology. The problem which generally faces us at the postmortem is, why the kidney did not do what was required of it, and, incidentally, what was actually required. The simplest sort of kidney failure would be where too much was required, which divides itself into two main groups—(1) overtaxing, (2) reduction of efficiency—generally there is something of both in any given case. We must set about getting some adequate measure of the caliber of each kidney we see.

The variation of size or, what is more to the point, **working capacity** of the kidney may vary greatly. It is not enough, therefore, to establish an absolute standard either of size or output, for one with experience knows that the whole matter rests on the requirements of the body that the kidney is working for. The caliber must be judged wholly with relation to the caliber of the body; again, not by bulk, but by work done.

An active little fellow, engaged in hard manual labor and using a highly nitrogenous diet, will require as much kidney caliber as a sedentary giant (unless that giant eats inordinately). It must not be forgotten that the kidney takes care of brain waste products as well as those from muscles, and that digestive waste and poisons are more important than either.

So the caliber of the body with which the kidney caliber is to harmonize is judged by the work handed over by every part and organ of the body that has any possible contribution to give.

The modern tendency to regard the kidney condition as the cause rather than the result of conditions elsewhere is the height of unreason. This is a natural result of confusing the effects produced by a kidney condition which has been induced, which is only a small part of the whole process, with true causation, and arises from a vicious habit of thinking only in terms of acquired or developed pathologic lesions.

To escape such grievous errors one must resist the temptation to consider lesions as causes rather than effects, unless they are clearly such, which is only the case in the advanced stages. Biologists may debate about how acquired characteristics arise and may even question the possibility of their arising, but every pathologist should know that they constitute the great mass of the content of his science.

One wonders, when reading the works on kidney lesions, why it is so seldom brought out clearly that the intestines have a mighty influence; even though urinology is full of discussions about the ethereal sulphates and other products that arise mainly in the gut, and the postmortem shows that very frequently there is an intestinal disturbance antedating the kidney lesion.

The kidney condition will not be understood until the condition and history of the gut has been mastered.

The relation of the circulation to the kidney has received a disproportionally large amount of attention; not always of high quality, however. It is always important to know what amount of blood is going to the kidney and under what pressure it is when it reaches that organ. These facts are often best learned directly from the vessels of the kidney before it has been disturbed by the routine mishandling.

Any habitual change of blood-pressure in the vessels of the kidney must show itself in those vessels.

The size, shape, tortuosity, thickness, and tendency to gape on section are to be noted in the arteries, which are apt to be empty. The veins help a little, but, in general, what they tell is a very different matter. If large and full, they may indicate local stasis, increased duty, or obstruction somewhere centrad in the system, so that by a comparison we can usually determine whether the circulation was weak or strong, the return blood retarded, or some obstruction existed in the kidney itself.

The relation of the activity of the nervous system to kidney action is too well established to be forgotten, but this action is of a dual nature: first, by a very direct and important action on the parenchyma and circulation; second, by the substances contributing to the work to be done.

Any evidence of trophic or other nerve tone lesion or condition found in the body must be considered when the kidney is being studied.

Every other organ has some influence, but this is increased when such organ is affected or diseased. This is quite easily observed when the liver is involved, either temporarily or chronically. In all profound affections of the blood the kidney shares and often suffers severely. In toxic conditions, whether from parasites or medicines recklessly given or poisons otherwise introduced into the system, the kidney actually suffers; at times by burden, at times by irritation, occasionally

by parenchyma intoxication with destructive change. Such toxic effects vary in intensity and in selective action on the different parts of the organ.

Direct infection and primary diseases of the kidney are not rare, but do not constitute a large proportion of the conditions we must study.

The significance of the **position** of the kidney is partly indicated when we find that it is no longer attached or is in some abnormal place. It should be remembered that it is in the abdominal cavity and shares in the dynamics of that region, both by the rhythmic respiratory changes and by the more irregular motions of digestion. The relations with the mobile lumbar spine and the diaphragm still further influence the organ. The perinephritic fat, which in some cases is excessive, modifies but does not wholly nullify these effects due to mobility of adjacent parts and organs, and it is more than probable that the encroachment of this fat has a direct influence on the health of the kidney. Certain it is that one seldom if ever finds a healthy kidney in such a mass of fat. The peritoneum is so spread over the front of the kidneys as to protect them from direct infections when that membrane is infected, and the capsule of the kidney forms a very resistant barrier to such infections as reach the tissue immediately around it. (See the various figures of dissections.) The action of the large skeletal muscles and the tug of the pulsating aorta should not be forgotten. Variations in these various normal factors and surrounding influences should be considered, even though our knowledge of their significance is far from complete; in fact, greater attention should be given to them for that very reason.

The **dissection** of the kidney should be carried out in such a way as to secure the greatest possible insight into its condition. It should be more carefully studied *in situ* than is usual.

For demonstration and class work the usual method of cutting the kidney through its middle in a plane parallel with its greatest surface is probably the best, but it always causes more or less squeezing, which is undesirable. I find that a transverse cut, from without inward toward the pelvis, has certain advantages:

(*a*) It can be made with less compression, and that can be restricted to one-half.

(*b*) It gives a better conception of distortions which affect the direction of the tubules.

(*c*) It can be made before the organ is severed from any of its important attachments.

(*d*) It opens the pelvis in such a way that its contents and condition can be better investigated.

(*e*) It interferes less with secondary cuts, which are often most necessary.

(*f*) It is specially desirable where cysts or stones lie along the usual plane of cutting.

(*g*) It makes the fracture or tearing of a portion of the organ more easy and complete.

(*h*) The cut surfaces can more easily be replaced in position, which is to be further facilitated by faintly notching the cut.

The **capsule,** being part of the fibrous skeleton, varies by itself and in its attachment to the rest of that structure, so that it may become thick or adherent if this skeleton is increased in amount. The finger-nail was used in the primitive days to test this adhesion, but modern decency demands rubber gloves, and the useful finger-nail being covered, a pair of forceps or the blade of a knife may be used. Where the adhesion is marked I find it convenient to cut a bit of the kidney away from the organ, but still attached to the capsule. This furnishes an excellent handle, and the adhesion can be tested by pulling on this bit. The general stripping of the capsule is undesirable because it disturbs the local circulation and appearance and injures the specimen if a histologic study of the organ is to be made. The adhesion of the capsule depends in part on the continuation of the fibrous skeleton into it, but it also depends in part on the adhesion to the directly adjacent parenchyma. Changes in the parenchyma are frequently the cause of lowered adhesion of the capsule. One should consider why bits of parenchyma come away with the capsule, remembering that changes in either the parenchyma or interstitial substances may affect the result.

The **cortex** is undoubtedly the most important part of the secreting mechanism, and its condition must be read much as one would read a foreign language, only after learning it. One cannot learn the language of the kidney from either macroscopic or microscopic study alone, but, once learned, one can do much from either, but always more from both.

The appearance of the surface as seen through the capsule, and of a portion after the capsule has been removed, must be compared with a section or, better, several sections, in different planes, and the appearance after fracture; these, taken with the force required to cut and fracture, and the manner in which the tissue gives way during tearing, all help to give a true conception of the actual conditions.

In order to properly study the fracture it is best to make a nick near the first transverse cut, say $\frac{1}{4}$ to $\frac{1}{2}$ inch away, carry this down about $\frac{1}{3}$ inch into the substance; grasp this bit between the thumb and fingers, and carefully tear off a block down to the pelvis. Too great or sudden force is to be avoided, and as the tearing proceeds slowly and gradually one must watch minutely how each structure and area gives way—vessels as well as parenchyma and skeleton.

I have never known any one who mastered the technic and the significance of this method who was not more than pleased with the insight it gives.

The naked-eye appearance of the pyramids, interpyramidal tissue, and the papillæ all tell us of the condition of the organ, each telling something not to be gotten in any other way.

The clean, quick, properly directed, and limited cut across the middle gives us a fresh view, provided we can control our impulses to handle and play with the surface before we observe it. The organ should be clean and dry before it is cut and the knife clean and free from oil or excess of water. After our first view we may gain further information by gently "sponging" with dry gauze, or by passing the knife backward

over the surface, or by scraping gently with the knife at a right angle with the surface. As a last resort we may wash the surface or apply various solutions to it, or may macerate it.

The use of water on tissue before it is observed is a wholly vicious practice, and specially so in connection with the kidney.

The complete dehydration of the usual modern histologic methods so entirely destroys the evidence of all moderate watery swelling as to obliterate much that is important; hence, it becomes the more desirable to make such macroscopic observation as will neutralize this source of error, and this can best be done by observing the masses of tissue affected.

The **pelvis** is subject to very considerable variations of type and structure, the significance of which may not be determinable, but the variations of condition are always important. One frequently finds evidence of irritation and not infrequently pus. It should be remembered that a cloudy fluid may contain crystals, precipitates of an amorphous type, epithelium or pus corpuscles, and that postmortem changes occur which may cause the fluid to resemble pus; also that bacteria may increase rapidly. Whenever possible the reason for such findings should be determined.

It is well, while preparing to fracture the organ, to squeeze a portion of the kidney so as to force out any contained matter or fluid, and observe it as it accumulates on the tip of the papilla. Mechanical obstructions of various sorts to the outflow of urine produce serious distention of the pelvis with more or less secondary change in the kidney. Such obstructions occurring within the kidney mass produce cysts, and when they are abundant they are generally classified as "congenitally cystic"; many of these are, however, catarrhal occlusion cysts.

The **blood-vessels** vary greatly as to size, walls, distribution, and the picture they present. These variations are associated with active and passive congestion and with changes in blood-pressure, and are seen whenever some unusual strain has been put on the kidney. They appear engorged or compressed or gaping, depending on the balance of blood-pressure with intracapsular tension. This intracapsular tension is, in turn, often dependent on circulatory conditions. Probably no more difficult problem presents itself than this of tension. Normally, the capsule is very elastic and allows of large change of size, both with the regular pulsation and by increased functional determination. In this elasticity the whole fibrous skeleton or, if one prefers the term, the interstitial substance takes part. Usually this skeleton changes with the capsule, and when elasticity is lost by the deposit of contracting fibrosis the contained areas as well as the whole suffers constriction.

This is not to be confused with the deposit of inert fibrin, nor again with a normal contraction resulting from atrophy of parenchyma.

The actual amount of blood in the internal vessels can often be determined by placing a thin slice in an excess of water. The amount of blood exuding from the surface of a section made without compression is to be compared with any increase produced by pressure.

The last and often best test is the fracture of the tissue, which shows the areas included in the skeleton being compressed and yielding to the breaking strain. The surface vessels generally give us information as to the type of chronic condition, while the tiny red points in the cortex and the fine radiating lines tell us of the acute condition.

It is impossible to interpret the kidney properly without a careful study of the physical properties of its substance in each case.

Appearance alone is not sufficient, though the way the light which enters the organ is reflected back to the eye often tells us much. It is at times necessary to change the illumination, as one does with the microscope, to bring out the deep reflection. But with inspection must be correlated all that can be learned by careful handling, and this includes traction, twisting, compression, and fracture.

Having judged of the normal work probably required by the body and of the pathologic work added by the conditions, and having judged of the size and condition of the secreting mass; of the blood-supply; of the structural handicaps, whether of size, fibrosis, or degeneration; of texture, consistency, elasticity, and other evidences of condition, one is ready to begin to consider special evidence of pathologic changes which temporarily or permanently affect the caliber of the organ.

It must be remembered that many conditions in other organs produce what might be properly spoken of as physiologic changes in the kidneys. Thus, shock of the central nervous system generally is seen by a change in the kidney, and I have a number of times decided to examine the brain simply from the appearance of the kidney, though no suspicion had existed of brain lesion. This is, of course, well known in regard to the variation of the flow of urine in conditions of the nervous system, but it is often forgotten that the appearance changes when the flow of urine changes.

The secondary effects of infections on the kidney are very striking and often very severe. While the kidneys are deeply placed, they nevertheless share in those injuries that arise from changes of heat and cold which produce shock and exhaustion to the vasomotor mechanism, and give rise to "colds."

Just at present the extreme of bacterial unreason is being checked along certain lines, but, unfortunately, the conception of a cold as anything but an infection has far too little place in our thinking. Colds (or if you prefer, vasomotor disturbances), nerve perturbations, digestive variations, drugs, infections, all cause chemical as well as vasomotor disturbances which profoundly influence the kidneys. The chemical factors are specially potent because the substances are then concentrated on the excreting membrane. In every condition where there is chemical imbalance or toxic addition there must be a kidney effect. It must be remembered that the kidney is the passive recipient of a vast amount of chemical abuse before it shows lesions of a truly pathologic grade. The primary lesions of the kidney form a rather limited group, fully treated of in the works on pathology.

THE PELVIS

In a general way the pelvis is simply a portion of the abdominal cavity, but it presents some interesting and important considerations. As a result of the upright position of man it has assumed a function of support for the viscera not usual in the other animals. The amount of support afforded depends not a little on the condition of the other supporting structures and of the organs supported, and the effect on the contained organs of the pelvis is very considerable.

There is another effect of the upright position, that on the return of blood. Not infrequently one hears strange discussions of portal obstruction due to liver conditions causing venous stasis about the pelvis. A glance at the parts ought to correct this, for the vena cava is so much larger and has such a different distribution that these errors should not be retained. The way the vena cava and its branches are exposed to pressure at the rim of the pelvis is of no small significance in all problems of venous engorgements below. While the mechanical factors are of limited influence, in most cases there are many conditions in which they are the important and determining ones.

One cannot fully understand the pelvis and the conditions found there unless one grasps all the mechanical problems involved in posture.

While considering the thorax we discussed the effect on the heart of the upright and horizontal postures. We now find in the pelvis a corollary to the proposition of the value of the upright posture for the laboring heart; this is, that the horizontal or even the inverted position helps the overburdened abdominal venous system.

The surgeons discovered that by elevating the hips the pelvis was emptied, and that the pressure was relieved on the pelvic floor, but the Mohammedan, who habitually maintains an upright posture, finds a peculiar posture for prayer which gives the pelvic vessels a rest and the brain a blood-bath by simple hydrostatics. The ultimate effect of continuous standing and sitting will depend on the chemical and nervous tone of the parts quite as much as on the mechanical influences, so that conditions we find must be analyzed with due regard to all three. After we have mastered these, but not before, can we estimate the influence of unusual or morbid conditions which modify either of these groups. Distentions of bladder, rectum, or uterus are common modifiers, but local infections are also important as affecting the local tone.

It is a singular and striking fact that the psoas muscles are seldom pictured in their relations to the pelvic and abdominal organs in anatomies, though their action on these viscera during walking is an extremely important part of the benefit of that exercise, and the relation that exists with the abdominal constrictors is seen when we attempt to forcibly contract the psoas muscles, and as the effort increases

irradiation takes place with fixation of the abdominal wall. There is just the same necessity to understand the working of the pelvis as a whole, and the effects of atrophy by disuse of its muscles and the results on the coördinated structures, as there is to study such findings in the heart.

Unfortunately, there still remains in medicine too much of the desire to find a morbific entity. This legacy has come down to us from the days when disease was a demon residing in the body. Our postmortems still show the influence of this interesting belief, but we cannot expect right thinking to dominate until modern methods are adopted. We must regard the machine as if we were sensible mechanics, instead of diverting our minds with clamor for some pathologic entity that has bewitched, in some occult way, its workings.

The proper judgment of the pelvis as a whole precedes any true understanding of its contained organs, and, while it is not necessary to have an extensive mass of data regarding a particular pelvis in order to understand a stone in the bladder, it is surprising how often an otherwise difficult case becomes luminous with the light thrown by a little careful study of the pelvis as a whole. The geography of the pelvis is to be taken up in an orderly way, but the order may vary much.

DISSECTION

In general, the peritoneal surfaces are to be viewed and tested before cutting is resorted to, and after this the peritoneum is to be loosened so as to bring into view the great vessels and ureters. Then, if there is no special indication for modifying the proceedings, the whole pelvic contents are to be shelled out by careful dissection, using as little force and compression as possible. At times compression of the contents will yield us valuable information as to the condition of the blood-vessels and ureters, specially if there has been some stasis or distention of some pelvic organ. At times one wishes to procure urine for examination, and this may be done by compressing the bladder, noting the ureters carefully to see if they fill, or it may be done by opening the bladder directly.

The removal of the mass from the pelvis at times should be complete; at other times the organs may be dissected out separately and removed.

It is seldom desirable to cut the perineum, and, though this method is advocated by certain writers, it should be practised only for very definite reasons.

It is rarely of advantage to keep the ureters connected with the kidneys, and, even when they are infected and are to be studied bacteriologically, such a method has grave disadvantages by reason of the displacement of the contents by the handling and compression, and it is generally better to cut them at the brim of the true pelvis. If they are to be later studied as a whole, such cuts are made as will present definite irregularity to facilitate accurate replacing of the cut ends. The

greater freedom of dissection attained by taking the organs out as a mass is at times attended with certain disadvantages, specially where the circulation is to be studied. In such cases the pubic bone should be sawed through on both sides, forming a wedge about 4 inches wide above and about $2\frac{1}{2}$ inches below. Where only a routine examination of the more important organs is to be made, the organs are opened *in situ*, without either removal or extensive dissection.

THE BLADDER

The bladder shows the influence of the conditions of the urine, of the nervous system, of the urethral history, and of general tissue changes.

FIG. 216.—An enormously distended bladder, extending far above the umbilicus, which is seen with the remains of the urachus leading to it from the bladder. Note also how markedly the pericardium is bulged by the dilated heart. The intra-abdominal pressure could not but be a serious factor in impeding the heart's action.

The distention beyond the usual at once suggests two main groups of causes—brain lesion and urethral condition.

THE URINE

While the study of the urine is seldom made at the postmortem, no properly equipped postmortem room should be without the apparatus and reagents to determine the general physical and chemical characters.

More than once have I been enabled from the tiny gas bubbles to escape overlooking a diabetes. The odor and color and transparency of the urine convey much to the skilled urinologist that is overlooked and missed by the histologist. I do not know of any other part of diagnosis, either clinical or postmortem, where the entire futility of the histologic methods is so apparent as in the matter of the urine, yet, strangely enough, the cytology of the urine is only crudely developed in general practice. I always am grateful for the biologic training that taught me to use Lugol's iodin solution in the study of cells, for I know of no reagent that so beautifully brings out not only the structure, but the condition of the cells and differentiates protoplasmic from other granular débris.

The use of small pieces of glass in the microscopic examination is another common mistake. I always use large ones and low power at first, and let the Lugol's solution join the urine at one side, while the line of union is closely watched. To collect urine from a partly filled bladder the most convenient way is to take a small 2-ounce, wide-mouthed bottle—clean of course—grasp the front of the fundus, raise it gently, and make a small cut near the forceps; then, by pushing the bottle down on the bladder, at the side, the urine will flow out of the cut into the bottle. If the bladder is nearly empty the cut is extended and the bottle is used as a scoop. Care must be exercised to prevent blood and other foreign matter from entering and contaminating the contents.

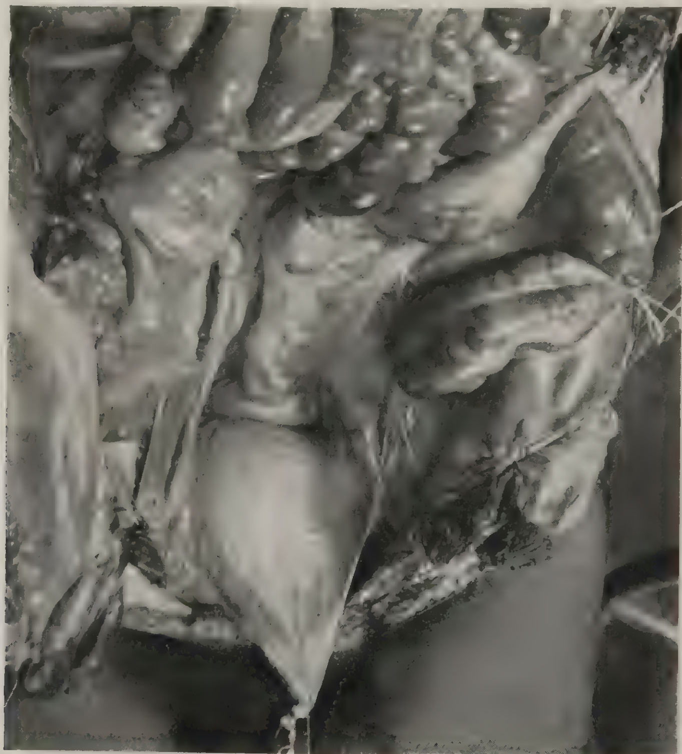
It must be remembered that postmortem changes may progress rapidly, and fermentation and decomposition are more apt to take place in abnormal than in normal conditions. The sediment may be greatly increased and the odor modified by such changes. Albumin is apt to appear from change in the bladder wall. Sugar tends to become less and acidity is diminished. Such changes can usually be judged, specially if the microscope and Lugol's solution are used.

The postmortem changes in the bladder are similar to those in other mucous membranes, and there is almost always some reduction of the color where there had been congestion, so that what is found should be multiplied by a small factor to obtain a true estimate. Pus is a very common finding, and it often comes directly from a cystitis, but the condition of the bladder, the urine, the ureters, and the pelves of the kidney must be compared before drawing definite conclusions.

Cystitis is common where inflammations are present or have existed in the sexual organs, and is often a valuable index of the sort of infection that has existed.

HERNIAS

While the common *hernias* do not occur within the pelvis, they generally are intimately associated with the problems of the support of the



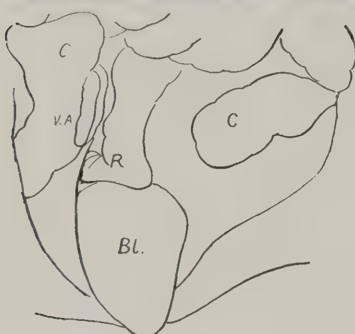


Fig. 217a.

Fig. 217—Male Pelvis, A.

The small gut is retracted upward, the descending colon to the left side, the bladder downward. Organs all nearly normal. Young subject. (Compare with Figs. 218, 219.)

C. Colon. *Bl.* Bladder. *R.* Rectum. *V.A.* Vermiform appendix.

abdominal organs, and these problems form a most important part of the study of the pelvis. The majority of the hernias I have seen were due to deficiency of supporting structure; some few were the result of traceable effects of violence, either surgical, accidental, or criminal,

where the supports were normal; a few resulted from childbirth; some from the simple hypertrophy of the parts, which being abnormal, were too much for the normal supports; more occurred by muscular action. It becomes necessary, therefore, to consider the nature of the sup-

Fig. 218.—Male Pelvis, B.

The peritoneum has been removed; the head of the colon turned upward; the sigmoid straightened and made tense.

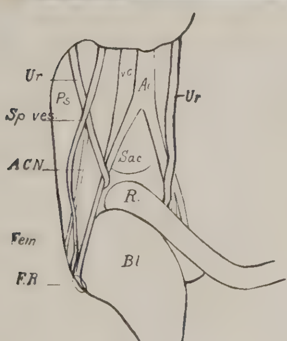


Fig. 218*a*.

Ao. Aorta. *Bl.* Bladder. *A.C.N.* Anterior crural nerve. *F.R.* Femoral ring. *Ps.* Psoas muscle. *R.* Rectum. *Sac.* Sacrum. *Sp.Ves.* Spermatic vessels. *Ur.* Ureters. *V.C.* Vena cava.

porting tissues in general, as we have already done in thorax and abdomen, and of the special structures, to be sure whether the defect is local or general. With this is closely correlated the muscles which cause constriction of the belly and increase intra-abdominal pressure,

as well as those which by contraction tend to give support and thus form part of the active support.

Everything tending to produce intra-abdominal tension may contribute to the formation of hernia.

Certain forms of auto-intoxication which may be associated with constipation seem to be associated with fibrolysis that is general, and if there is constipation, hernia follows as a natural result from straining at stool. The type of development of the muscles associated with purposeful constriction of the belly or fixation of the wall for general muscular effort is part of the study of hernia, without which no examination is satisfactory. Occasionally one finds a condition clearly congenital, where everything else but the rings appear fairly normal.

Generally, one finds clearly marked peculiarities in the distribution of the supporting tissue, not simply where the hernia is found, but at other points. Thus, if a hernia is found at one ring, one is apt to find the other rings, the umbilicus, the central tendinous part of the diaphragm, the pericardium, and various other supporting structures sharing in a common peculiarity of type. What is found in the sac or hernia mass will depend quite as much on the supports of the organs as on the position of the hernia.

The **contents** should be studied, both in regard to causation and effects, and the various conditions resulting within and beyond should be carefully considered together.

Not infrequently one finds that the sac has been occupied by different structures at different times, and that secondary changes have resulted in parts no longer composing the hernial mass.

Every organ of the body may conceivably form part of a hernia, but one may with propriety question whether a classification that includes everything does not cease to be a classification. It would seem better to be more careful to separate displacements and protrusions from hernias proper, just as one usually does invagination, constriction, compression, extrusion, prolapse, ptosis. Still we hear of cerebral hernia where an extrusion of the brain is what is meant.

It is eminently desirable that postmortem descriptions should be made with special care, and in using terms not to follow too closely either the thoughtless fashions of the time or the mistakes of former periods.

The **effect** on the contained part may be difficult to investigate after death, and one must reason carefully and correctly regarding what must and what may have been the effects in each case, and, so far as possible, collate such results of thinking on the things observed with all obtainable history. The commonest effect is compression, which may change the circulation to or from the part or of adjacent parts; then the nerve compression must not be ignored. Usually the peculiar activity of the organ is more or less interfered with, and often other organs are affected. It will be readily seen that a hernia often offers intricate problems far exceeding its immediate practical importance so far as life and death are concerned. For a beginner it affords an

excellent opportunity for the training of hand and mind that is so necessary, and as it usually attracts his attention and interests him, because he heard so much about hernias at school, there is less trouble in fixing his attention on the work necessary.

The **dissection** of a hernia requires considerable skill and thought. No two should be treated in exactly the same way. One should be emptied by traction at first, while another should be reduced from without by compression. Many should be dissected before reducing. Never should anything be cut or handled until all that can be seen is first noted. Then, after settling on the mode of approach, the dissection should be cautiously followed out.

In ordinary hernias at the pelvic brim it is seldom necessary to make extensive skin cuts. The various figures show how the skin may be retracted and freed by subcutaneous cuts in the muscles and inner walls, so as to give free access to the various parts of the canals. When to cut freely and when to dissect by layers can only be determined in the individual case after study of conditions. In general, avoid all unnecessary cutting, and always cut with a view to subsequent replacement or reconstruction, using sharp angles and notches as guides, no matter what may be written or taught about smooth cuts and picturesque dissection. I had to find this most valuable principle out for myself, and have been subjected to some unthinking criticism, but I know its value, and am sorry it has not wider recognition.

MALE SEXUAL ORGANS

WHILE all organs tell us but a limited amount of the story of their life, it is our business to find out all that they do tell. The male sexual organs always show congenital type, sometimes they display the personal history, and not infrequently there is a pathologic present or past. The general architecture corresponds with their purpose, and this differs somewhat with the type of individual, but does not vary greatly as the result of personal history.

Each apparently insignificant element has its importance, and tends to modify the details of the manner of functioning, which react on the various other organs, so that no study of a body is complete that ignores the recognition of the type and condition of the sex organs. It is equally desirable to avoid the stultifying modesty of certain writers and the disgusting prurience of others in considering the relations of sex to life and death, to health and disease. At present we are too prone to consider only the pathology on one side and the whims and fancies of sociologic talkers on the other.

The postmortem should reveal something more than the anatomy and pathology of this group of organs.

EXTERNAL GENITALIA

The external genitalia often present anatomic peculiarities of size, shape, symmetry; of development, defect, deformity; of color, care or cleanliness, and condition. Much has been written about discharges of various sorts, and it is important to recognize the discharges of inflammation and to consider all normal ones carefully. One should not conclude hastily, as is often done, that seminal fluid means either a sexual act or a violent death, for it often occurs as a simple leaking from distended seminal vesicles. Varicocele may remain or disappear after death, depending on conditions, of which cold is a most important factor, and the position of the body and of the parts is another factor.

Any fulness of veins of the abdomen may cause a positive venous pressure which may overcome the other influences. The development and condition of the skin of the various parts, its glands and hair and infections, as well as parasites, are at times of much significance.

DISSECTION

The dissection of the complete apparatus is seldom necessary, but is at times desirable. Usually, however, the inspection and palpation is sufficient to determine whether any serious disorder exists. What dissection is desirable will depend entirely on indications found or known to exist from the history.

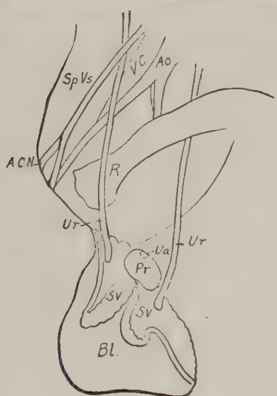


FIG. 219*a*.

FIG. 219.—MALE PELVIS, C.

The bladder has been freed and brought out, and the seminal vesicles cleared. A probe enters the bladder through the urethra.

A.C.N. Anterior crural nerve. *Ao.* Aorta. *Bl.* Bladder. *Pr.* Prostate. *R.* Rectum. *S.V.* Seminal vesicles. *Sp.Vs.* Spermatic vessels. *Ua.* Urethra. *Ur.* Ureters. *V.C.* Vena cava.

The examination may be made while the organs are in position, or the whole apparatus may be removed as a mass, but if mass removal is practised care should be exercised to particularly note the geography

and blood distribution before dissection begins, and it is well to avoid disfiguring the body.

When all the viscera are removed together the urethra is cut near the prostatic portion, and the testicles may be slipped out of the scrotum

Fig. 220.—Male Sexual Organs.

Bl. Bladder. *C.* Colon. *Ex.Il.* External iliac artery. *Fem.* Femoral ring. *Ing.* Inguinal ring. *Lv.* Liver. *Ps.* Penis. *Sp.Cd.* Spermatic cord. *Sp.Vn.* Spermatic vein. *Sym.* Symphysis pubis. *Ts.* Testicle. *Ur.* Ureter. *Vas.* Vas deferens.

The head of the colon with the peritoneum is raised. The skin about the pubis is retracted by strings to the toes. The skin of the penis is invaginated as far as the glans. The testicles are removed from the scrotum. The right testicle is freed from its outer coverings and shows the course of the vas, the right inguinal ring having been opened. The mass may be removed by making two saw cuts in the symphysis just inside of the inguinal rings slanting slightly inward toward the lower part of the cut. (Compare with Fig. 219.)

either by cutting the inguinal ring or by traction or external pressure. Care should be used to avoid too great pressure. For the dissection of the apparatus as a whole the pubic skin is dissected and reflected and held by means of string retraction. The skin of the penis is freed as

far as the corona and the inguinal canals opened. The bladder is freed and the symphysis cut away in a wedge shape.

Generally a less tedious process is sufficient, and an excellent view of the parts can be gained by simply approaching the organs from two directions, as shown in the illustrations. In examining the penis it is better to cut it, if at all, close to its attachment to the pelvis rather than behind the corona, as is frequently done.

The simple invagination of the scrotum by gentle pressure from without, after opening the inguinal canal, is better than using traction.

The dissection of the tunics of the testicle is seldom necessary, and if there has been inflammatory process this will be difficult. Generally all that is desirable will be accomplished by cutting through these tunics at various places. Much depends on the condition of these tunics. Where varicose veins are present I always try to dissect by layers, so as to avoid as far as possible cutting the vessels. Much can be done to clear up an obscure history by a careful study of this apparatus, so that we should be ever ready to dissect even to minute details.

The pelvic portion, consisting of the vessels to and from the organs, the special ducts from the testicle and the receptacles, are clearly shown in the figures. In all studies of the parts avoid undue pressure on structures containing fluids, specially the **seminal vesicles.** These structures show great variations, and are often the seat of disease, and their contents tell much by their character of the recent changes.

The **urethra** is a wonderfully resistant tube, but it suffers severely at times, and as a result one finds many lesions whose interpretation will often puzzle if not baffle the careful and experienced observer. Smallness should not be mistaken for stricture, and discharges with inflammation must be considered as to their extent, severity, and the evident involvement of related structures. Inguinal glands do not draw all their infection from the sexual organs. This seems a very trite observation, but it is too often forgotten and wrong conclusions drawn regarding the source of the infection.

FEMALE SEXUAL ORGANS

The female sexual organs have not developed externally as have the male, and the sex glands have descended into the pelvis, but do not even approach the inguinal ring except in hermaphrodites. The whole apparatus can be best understood if we regard it as a specialized form of inversion of the male development. Only in this way will we realize the homologies of the various parts, and be able to properly value the significance of type variations and of anomalous conditions.

The whole of the essential organs are intrapelvic, whereas those of the male are extrapelvic.

Curiously enough, the examination of the male requires cutting, and this is best done from within, while the female can be examined very completely from the exterior, as is done by the gynecologist, though it is more satisfactorily done from the inner or pelvic side.

The examination of the lower segment of the canal and of the external genitalia is to be made with the legs widely separated. There are times when a regard for the feelings of modesty of those present require consideration, and this external examination must be reduced to the least possible extent. In such cases I confine my observation to a quick, careful inspection of the external parts with so much display of the parts as is necessary and no undue uncovering.

I have seen great offense given by disregard to this thoughtfulness by men who should have known better. To the pure all things are pure, but that unfortunately applies to but a small part of the human race, and not all postmortem artists belong in this group. It is imperative, therefore, that all operators cultivate a decent respect for the feeling of others, lest one degenerate to the level of a certain type of medical beast too frequently found in continental Europe. There is nothing which disgusts a decent person, whether lay, student, or medical practitioner, more quickly or thoroughly than disrespect to the dead woman at a postmortem. The display of vulgarity, either by act or word, in no way assists the conscientious worker in his legitimate work. Any tendency to prurience at a postmortem, either on the part of the operator or of observers, whether lay or medical, should be absolutely eliminated.

I am glad to say that one sees little of this sort of thing in this country, but there should be none of it. My rule is to do nothing at a postmortem that I should object to have another do under similar conditions on a member of my own family. The vulgarities of the dissecting room have done much to lower the students and to belittle the profession in the thoughts of the whole world.

The examination of the external openings is facilitated by the use of the hair as a retractor, and the handle of the sequestrum forceps

furnishes a good speculum. The conditions to be found are fairly well described in any of the better text-books on gynecology. The post-mortem changes will consist chiefly in an increased pallor of the parts and more or less relaxation of the normal tension and some rigidity where rigor has set in. The later changes, due to the growth of bacteria and distention of the belly by decomposition gases, with actual putrefactive changes in the organs, all tend to seriously alter the appearance. The mucous membrane of the part should be studied before it is touched and the amount and type of secretion noted, as well as its location. The abdominal tension must be considered if the belly

Fig. 221.—Female Pelvis and Sex Organs. Type 2.

The intestines have been turned upward. The rectum, rather dark in color, is partly filled. The head of the colon with the appendix is in place. The uterus is displaced and has a small fibroid projecting. The left ovary is cystic and causes the displacement of the uterus. The bladder is partly filled and is compressed by the uterus. Above is seen the beginning of the duodenum. (Compare with Figs. 194, 195, 222.)

has not been opened. The majority of the conditions found belong to the discussion of pregnancy. Often there is considerable matter present, and one must be careful in drawing conclusions, even after a microscopic examination. Negative microscopic findings regarding spermatozoa or gonococci are not always conclusive. Always one must consider the nature of the peculiar secretions normally present and the limits of variations in such. Our knowledge of the flora is still unsatisfactory.

The approach through the pelvis should be made with more caution than is often used. Undue pressure on the parts is very apt to displace the contents of the hollow parts and to disarrange the contained blood.

The intestines generally cover the pelvic organs and not rarely are adherent to them. (See Fig. 194.) Where free, they will be gently lifted up and placed over the edge of the opening on the side away from the operator, or may be reflected upward. Where there are firm adhesions it may be impossible to dissect them free while in the pelvis, and at times dissection becomes carving. Where it is possible without too great disturbance of the parts the organs in the pelvic floor are displayed and examined before clearing out the pelvic mass. The position of the organs is often of importance, as is well known in gynecology. Misplacement, flexion, tumors, or cysts may compel us to adopt special dissection, but ordinarily, after carefully examining the separate parts and noting their relations and condition, the pelvic mass may be removed. This is best done by cutting and separating the structures

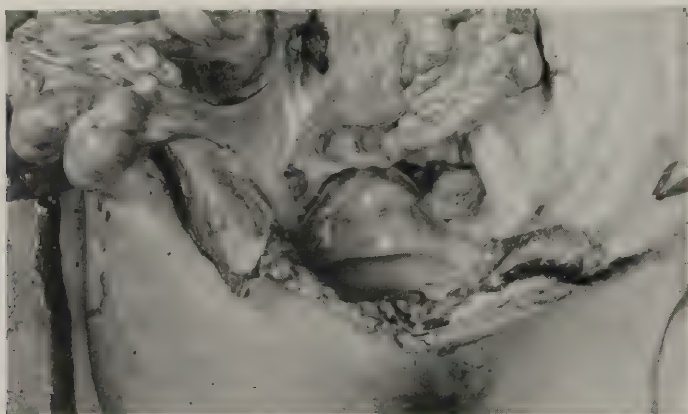


Fig. 222.—Female Pelvis and Sex Organs. Type 3.

The large flabby uterus is bent back and to the right. The bladder is nearly empty. The left ovary lies close to the pelvic wall, near the ridge of the psoas muscle. The head of the colon is seen to be loosely attached, and the appendix is doubled on itself. The rectum is well over on the right side. The peritoneum is considerably thickened and is roughened in areas, while the other supporting fiber-containing tissues are not proportionately affected.

connecting the mass with the pelvis, beginning in front, back of the symphysis, and working carefully downward and backward, avoiding as far as possible serious traction and compression, and using either a knife or long-handled scissors where resistance is encountered.

There are many conditions where the peritoneum will act as a retractor most conveniently, so that it is better not to cut it at the brim of the pelvis, as is sometimes advocated, but to shell it away from the abdominal wall, which can generally be done by working the fingers between it and the walls. If skilfully done, the pulling is all done against the peritoneum well above the brim of the pelvis, and the compression is thus reduced to a minimum.

At times a side-to-side cut at the bottom of Douglas' pouch allows the removal of the uterus, vagina, and bladder in a mass without disturbing the rectum. This is desirable when that organ or the wall

of the pelvis, with its adjacent blood-vessels and glands, are to be specially studied, but one must not forget to adapt his method to the actual and probable conditions, even if he has to remove the parts separately or in sections. If the uterus is pregnant, or there are large tumors present, or the adhesions to the pelvic walls are very firm, various modifications are necessary.

In cutting the vagina to remove the mass I find it best to cut it some little distance above the perineum or a little below its middle. This allows of a subsequent study of the condition of the perineal relations, which may be important. If the mass has been carefully freed in front and on the sides and back in the order given, and the peritoneum is drawn tense, the vagina is pulled on and is extended as soon as the attachments of the bladder and the urethra are cut, so that the tension should be slightly relaxed as the vagina is neared.

If the bladder is distended it may be desirable to empty it by gentle pressure or by catheter or by passing a large probe into it to relax the urethra, or it may be opened in front and not too high up, when it is emptied in the way described under the male bladder. In extra-uterine pregnancy or when thin-walled cysts are present special care should be taken to do the right thing, so as to avoid destroying relations and conditions before they are studied. In advanced pregnancy I deliver the whole contents of the uterus intact or in parts, going cautiously, for if there is detachment of the placenta or hemorrhage one has a very different problem than that presented in a normal condition. The slit is made in the upper front of the uterus from back to front and then downward, usually in the median plane.

On reaching the fetal membranes they are dissected from the uterus until a clear view is obtained of the uterine contents, and while making this separation any peculiarity of the junction is noted. If any indication is found for it the sac is opened and its contents examined, and it may be emptied of the fluids and fetus at once.

During the preliminary examination and the dissection all the problems of relationship between the uterus and its contents—size, shape, distention, position, inequalities in the wall, and the relations of the whole mass of uterus, with its contents, to all the surrounding structures—will have been observed. The significance of sizes, shapes, and positions of each part, and the factors of circulation, both venous and arterial, of nerve compression, of bladder and ureter interference, and of rectal compression or obstruction, as well as the general effect on the abdominal viscera, directly or indirectly, and the more or less indirect effect on the thoracic organs, must be considered, and with these naturally the condition of the belly walls and the muscular elements, as well as the fibrous supporting structures and the resulting position of the viscera.

To make a postmortem on a pregnant woman one must hold in one's mind the physiology of pregnancy and not simply look for pathologic findings, or the results will be a miserable waste of time and opportunity. There will remain a very large degree of mystery at best, but the vast problems of physical, chemical, and biologic import that center

in this condition not only tax our knowledge and insight to the utmost, but, if properly considered, will yield a rich return in understanding increased of all the phases of these factors as they affect health and disease. The empty uterus is a wonderfully simple organ, made up chiefly of slightly differentiated tissues of the class usually disregarded at the postmortem because they appear unimportant. The uterus, therefore, furnishes a striking example of the importance of uninteresting tissue. Nowhere are infections more serious or disturbances more

Fig. 223.—The Mass of Pelvic Organs from the Front.

Bl. Bladder. *l.ov.* Left ovary. *r.ov.* Right ovary. *R.* Rectum. *Tb.* Tube. *U.* Uterus. The bladder is seen relaxed, deeply injected, and covered with whitish lymph that extends over the pelvic peritoneum. The tubes are seen to be swollen, dark in color, due to congestion associated with inflammation. The ovaries are seen to be covered in by recent lymph and an old fibrous coat which is irregularly congested. Bits of lymph are seen in the upper left.

sure to affect bodily health, and complications in other organs often follow or give rise to grave conditions in this focus of the vital processes.

Habits of tissues, vessels, and nerves that are general manifest themselves here in a striking manner. The most important part of the technic of an examination of the female pelvic organs is mental rather than manual.

The uterus that has never been pregnant, and that of the old, usually show none of the evidences of distention and hypertrophy. Though

the blood-vessels may be large, in either case, it is rare to find them as large before pregnancy as afterward. The veins are often very large and at times tortuous and the sinuses in the wall distended. It is this condition which makes reckless curettement after delivery or abortion such a serious affair, and this condition of the veins often furnishes a ready path for infections to reach the general system. In all cases where death has come on suddenly following some surgical or obstetric work about the uterus these blood channels should be examined, and if a clot is found plugging an injured vessel or sinus it should be remem-

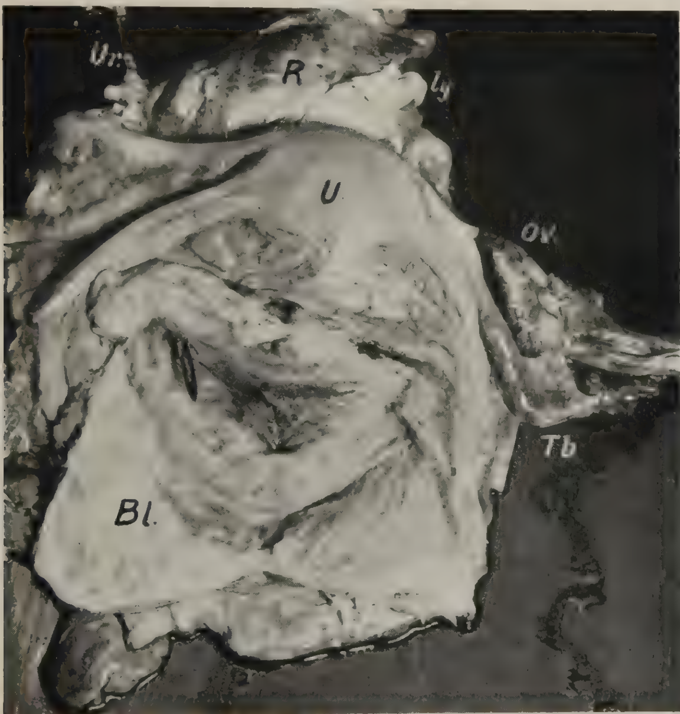


Fig. 224.—Compare with Fig. 223. The pelvic mass from the front with the position of the tubes and ovaries changed, and the bladder opened and a probe passing through the right ureter (*Ur.*). The bladder shows cystitis with dendritic injection and marked inflammation at the trigone. These two figures are from a case of criminal abortion which was followed by peritonitis by extension, the uterus having contracted. The ligaments of the uterus are well seen.

bered that such a clot offers less obstruction to the passage of bacteria, especially such as liquefy blood-serum, than does the uninjured vessel wall. Embolisms of clot or air are far less common in these conditions than is usually supposed. Gas-producing bacteria probably account for a large part of the observed emphysema formerly supposed to be from the entrance of air, and toxemia and shock for most of the cases of so-called embolism.

The **peritoneal** covering generally shows marked evidence of inflammation where infection has spread to the general peritoneal cavity.

The relative stage of advancement of this inflammation helps us to trace the source from which such infection came. In old inflammatory changes we often find a less resistance than in normal tissue, though such thickening tends to resist the passage of the infection in a purely mechanical way.

The **mucous membrane** of the vagina responds to the excitation of sexual excesses, and tactile papillæ grow and are often grouped in ridges in such cases.

Much can be learned by a careful comparison of the vaginal with other mucous membranes. Catarrhal conditions are common, and vary in type and degree as well as in the reaction and glandular involvement.

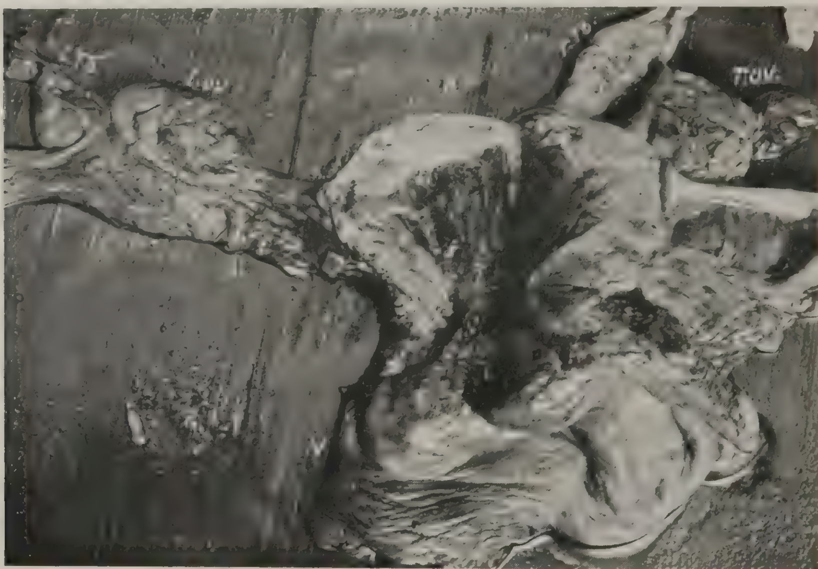


FIG. 225.—UTERUS OPENED FROM BEHIND.

l.Tb. Left tube. *l. ov.* Left ovary. *r.Tb.* Right tube. *r. ov.* Right ovary. *U.* Uterus. *V.* Vagina. The uterus has been recently pregnant and an abortion was committed. This was followed by a curettement. The inside shows a rough, congested, and infected surface. The cervix is very irregular due to old and recent injuries. The vagina is large, lax, and thickened. The ovaries are fibrosed.

That of the uterus is distinctly different in type, and when irritated, inflamed, or actually diseased the discharge varies much.

There are often glandular conditions about the cervix, with a tendency to the formation of cysts and pits, sometimes ridges, which might at times be mistaken for old injuries. The lining of the tubes is very often inflamed, and if the lower end becomes occluded there may be extension to the peritoneum.

It must be remembered that there is a large and but partly understood flora in the lower part of the canal; some of these forms may lead to disease without any contamination from other sources.

In children this is added to by the migrations from the rectum.

Such migrations may go as far as the kidney, and probably account for some of the so-called congenital cysts; certainly they cause serious infection of the bladder and vagina and folds of the external genitals, just as they produce sores in the skin. While this is well known by some, it escapes the attention of many clinicians as well as of some pathologists.

It is not rare to find different types of inflammation in the different membranes, and this is not surprising when we consider the varied secretions in which the microörganisms have to live as well as those through which they must have traveled.

During **menstruation** the uterine mucous membrane shows marked changes and the congestion may be apparent in the adjacent parts.

Fig. 226.—Compare with Fig. 225. The vascularity of the uterine wall is shown by dark areas in the upper cut surface. The ovaries have been sliced down to the attachment, and show many old scars. The left one contains a dark area corresponding to an old corpus luteum (*Cp.lt.I.*). The right has two bodies of clearly different ages, *II* being the corpus luteum of that pregnancy for which the fatal abortion was done, and is large and clearly in the early months. *III* is a remnant of a previous abortion. After considerable trouble it was learned that the woman had these abortions performed frequently.

Care must be taken not to confuse this condition with inflammatory changes or with an abortion. The finding of an ovulation corpuscle materially helps to clear the picture, and it is usually present and generally differs markedly from that of pregnancy. The distant effects of this process are often of moment, and may be very severe, even fatal.

The **tubes,** aside from showing local inflammation or that by extension from the birth canal, may be infected from the peritoneum. They may be greatly modified in size and shape and may contain purulent matter. It is sometimes necessary to consider the way a peritonitis has arisen from pus tubes, and one of the ways is by the milking of the contents during a gynecologic examination. I have traced quite a few such cases, and was able to confirm my suspicions by obtaining a clear

history of the examination being followed by the peritonitis. This has been known to occur following an abortion, and more than once

Fig. 227.—Pelvic Mass from Behind.

Fig. 228.—Uterus, Vagina, and Rectum Opened.

the evidence was conclusive that the infection of the peritoneum which caused death arose in this way. Whether the inflammation of the tubes is due to extension from the uterus is another problem in such cases.

Tubal pregnancies are fortunately less fatal than formerly, owing to the greater alertness of clinicians. Some of those I have seen should have been diagnosed during life. The history is usually clear enough to warrant the diagnosis before we cut, and the appearance of the body generally shows that a fatal hemorrhage has taken place. It is always well to carefully remove the clot so as to be able to recover the fetus if it has left the tube.

It should be remembered that pregnancy, while generally occurring in the cavity of the body of the uterus, may occur anywhere along either

FIG. 229.—Compare with Figs. 227, 228. The uterus is large and soft, but not flabby, and is severely infected. The outside shows congestion and lymph; the inside, a mass of bloody slime. There was profound septicemia from direct invasion of the veins of the uterus. The cervix is deeply eroded and irregular; the vagina contracted and ridged, but not profoundly affected. The rectum is seen below and is much wrinkled and covered with slime.

tube or even in the ovary. There is still some doubt whether the pregnancy can occur in a tube whose outer end is blocked. It is claimed that this has been seen as well as that it may occur in the tube opposite to the ovary from which the ovule came. To establish this great care is needed, both in examining the tubes and the ovaries. One should not forget that the tubes possess muscles capable of considerable action, so that it is probable some change in these is as important as that in the ciliated lining; also that tubal pregnancy is less frequent than is the destruction of the ciliated lining.

Perhaps here, also, we are forced to recognize the inadequacy of anatomy and will require a better understanding of the physiology. It is desirable but not always easy to estimate the age of the lesions found in the tubes, specially in cases where several successive infections have taken place, as not infrequently is the case in abortion. Sometimes the type of infection can be judged by the contents, more often by the degree and extent of reaction in the mucous membrane and walls, and at times by the condition of the fimbriated end. In order to investigate these tubes gentle bending is the most valuable mode of determining

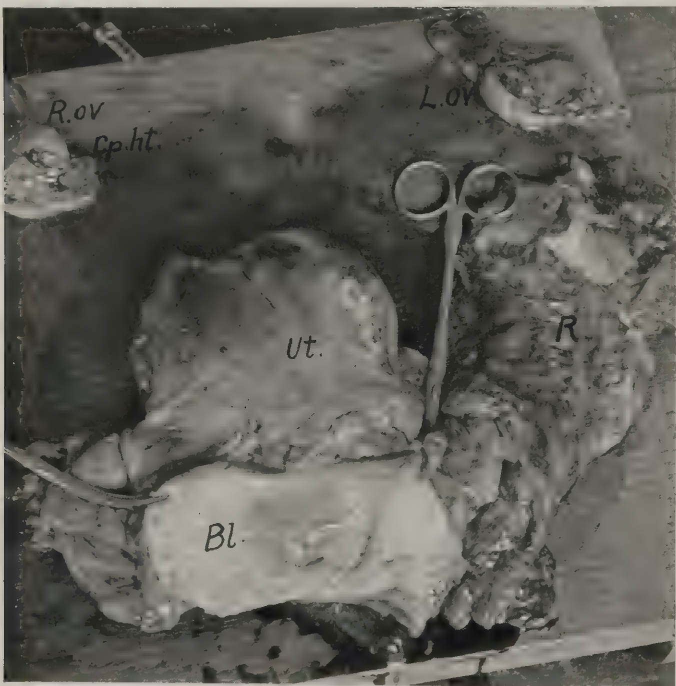


Fig. 230.—Compare with Figs. 227, 228, 229. Pelvic mass from the front. The bladder (*Bl.*) is opened and shows marked congestion in the region of the trigone. It is, however, well contracted. The right ovary (*R.ov.*) shows the corpus luteum of about the third month of pregnancy. The case was one of criminal abortion. The incision for opening the uterus appears running across the top.

the tissue change; this, with observation and carefully directed dissection, generally give the important factors.

The **ovary,** like the testicle, contains some of the primitive undifferentiated protoplasm, often called germ plasm. This is true archetypal protoplasm with all possible functions and properties retained, and it is for years kept dormant by some influence, most probably chemical, which inhibits its development. This influence is only shaken off when maturation and the discharge of a polar body takes place. This conception is of great service to us when we attempt to understand the chemical relations of the ovaries with life in general, with peculiarities of growth, and

with the special tissues that are active in internal secretion. Certain it is that the ovary shares with the suprarenals in origin, and from certain peculiar chemical relations we are enabled to understand the properties of the corpus luteum and the significance of the internal secretions on infantilism of the sexual organs. It also throws light on the pangenetic influence of all the bodily parts, probably largely chemical, on the forming, if not on the formed, ovule. This germ plasm or, as I prefer to call it, archetypal protoplasm, has an infinitesimal amount of anatomy and an infinite physiologic potential. It is hardly conceivable that its home, the ovary (and testicle), should not have a large return influence on the body as a whole.

PREGNANCY

There are certain features of pregnancy which deserve special consideration:

(1) The **diagnosis,** which in life depends very largely on the history, is generally simplified after death by the presence of the fetus.

The signs, such as pigmentation, condition of the breasts, presence of a tumor in the pelvis, and condition of the lower segment of the

Fig. 231.—The female breasts dissected from within, the ordinary skin-flaps being reflected so as to include the breasts; the right breast showing the under surface of the skin; the nipple being at the point <. The left breast is opened by a single cut.

Fig. 232.—The female breasts restored after dissection. (The chest being open and the left lung being in view.) Note the nipples surrounded by large pigmented areas. The woman had had a criminal abortion performed. Note the size of the breasts, and that there is practically no glandular substance present.

uterus, all have the same value at the postmortem as in life. Other signs which are more truly described as symptoms, and belong to the physiology of pregnancy, are lacking; little remains of the nausea, vomiting, the various subjective nervous symptoms, the various evidences of chemical change in other organs, pressure symptoms, sensation due to the muscular action of the fetus, and mental and emotional changes.

The degree of impression made on the general organism and on the special organs varies so greatly that one must be very careful in drawing conclusions from the findings alone.

Other things being equal, any peculiarities of construction or condition of the parts should tend to increase the general effects, and any weakness of the affected organs renders them more liable to show such effect. The pathology of pregnancy is difficult and requires extra care and caution, but is not to be neglected for these reasons; and in these cases I modify the routine greatly, often doing no cutting for some time, but carefully studying the various organs *in situ* until I am reasonably sure of their relative conditions, then I cut the pelvic organs first.

There are three vital considerations: (*a*) The physical effects of the resulting tumor; (*b*) the chemical effects of the pregnancy, both localized and general, from the action of the fetus and of the corpus luteum; (*c*) the vital effects not clearly chemical.

It will be seen that spurious pregnancy can and does cause many of these effects, though not all. A premature termination of pregnancy seldom causes an abrupt stoppage of the effects. The mechanical effects usually fade first, provided no violence was inflicted and the parts are of a fairly normal tone. The chemical effects may linger, depending on the stage of advancement and the extent of development of the peculiar glandular adjustments, such as are found in the corpus luteum and internal glands. The digestive and urinary adjustments vary greatly. The purely mental phenomena may have stopped the instant that it was known pregnancy had ceased, or the moral and maternal instincts may increase from that moment.

The rate of readjustment in all cases depends on the personal peculiarities, and on whether there have been previous pregnancies with or without premature terminations.

(2) **Normal adjustments** of pregnancy consist in marked circulatory changes locally, with more or less marked secondary ones at a distance from the pelvis. The internal glands all respond more or less by a definite change, often by an increase of function; the digestion is stimulated often to the point of irritation, so as to prepare it for the double strain of nourishing the fetus and uterus and of lactation. The liver, spleen, and kidney all share in this elusive but decided stimulation; probably the pancreas shares, though about this we have surprisingly little real observation.

Hypertrophy of many different parts have been noted. Each of these changes modifies the picture of the affected part at the postmortem and requires that we hold in mind this factor in every determination of the condition of the organs of the body.

These normal adjustments differ from those produced by sexual excitement or excess and menstruation, which, however, they resemble in some ways; all of these cause not only considerable local change in the sexual organs, but always show distant effects that at times are quite important. In addition, menstruation causes loss of blood, and all give rise to nervous, secretory, and internal chemical changes.

(3) The **fetus** maintains a fairly definite development, both as to size and evolution, so that one can fairly accurately judge of its age. It must be remembered that not a little variability may exist, so that it is better not to be too positive even about the exact number of weeks the pregnancy has lasted. So far as possible the history should be compared with the development of the fetus and the stage of the corpus luteum, as well as of the bodily organs and parts of the mother.

For convenience we may consider four stages:

(*a*) For two weeks from impregnation—the ovum stage—being hardly formed.

(*b*) For three weeks more—the embryonal stage—when the fetus is beginning to assume form, head and visceral arches, tail, and finally buds indicating coming limbs.

(*c*) From fifth week until viable apart from the mother, which by ancient and continental laws varied from—180 to 210 days after conception—fetal period.

In the 2d month the limbs are recognizable—mouth appears.
In the 3d month assumes human form, and sex is apparent.
In the 4th month hair appears—head is about one-fourth of whole.
In the 5th month nails appear—bile is found in the meconium.
In the 6th month vernix caseosa appears—color is dusky red.
In the 7th month subcutaneous fat—lanugo; may live.
In the 8th month lanugo decreases, nails reach tips of digits.
In the 9th month color less red; umbilicus has risen from the pubis.
Length, to 5th month, square of months; after months by 5 = cms.

(4) The **placenta,** which at maturity is an oval disk, usually thicker at the insertion of the vessel (cord), is about 18 cm. in diameter, 2 to 3 cm. thick, weighs over 1 pound (500 gm.). The variations in size, shape, and consistency are always significant, though, owing to insufficient observations on this important subject, reliable rules cannot be formulated for the interpretation of such irregularities, except that syphilis tends to produce large, heavy, and pale types.

Too little is known of the effect of pre-existing endometritis on the condition of the placenta, though we know that such effect is often so serious as to prevent or terminate prematurely or act seriously on an otherwise normal pregnancy. The way the placenta is attached to the wall of the uterus as well as its position, and whether there are peculiarities of vessels or of fibrous tissue, are most important. Detachment of a part or of the whole may result from violence or from abnormal conditions, and the hemorrhage that results depends on the cause to a large degree. This may be retained or may result in partial detachment, produce complete separation, or it may escape by the birth canal; its age and amount may often be determined, as well as the cause and effects.

(5) The **membranes of the fetus** form a sac which covers the placenta and the uterus and are more or less attached to them. The attachment to the placenta is intimate, while that to the uterus is generally slight. At times collections of more or less offensive material accumulate be-

tween the membrane and the uterus. I have seen this occur where the mucous plug in the os was apparently normal. Such a collection is generally a serious matter, both for the woman and for the child. I believe such sequelæ of endometritis are more common than is supposed, and that they cause sepsis after delivery in cases where the physician is blamed I am satisfied is not an extremely rare occurrence.

One might, in finding such an area after delivery, mistake it for an infection following labor if the examination was not made with great care. This is particularly significant in cases of supposed abortion by instrumental means. The amount of fluid in the sac may vary much, and may arise from oversecretion, underabsorption, or the reverse, or by actual disease. It is usually difficult to determine the cause after death unless there is actual disease, and then the other possible causes should not be forgotten. Generally it is alkaline, 2 to 3 pints (less at term), specific gravity 1010, but is variable.

(6) The **uterus** itself may have been incarcerated in the pelvis so as to cause great mechanical effects on the bladder or rectum, or on the vessels or ureters; it may even cause abortion, and after death following such an abortion it would only be judged to have been present by reason of the secondary effects it had produced. Such a condition of incarceration is not uncommon before the uterus rises into the abdomen, but it seldom by itself causes serious results. Normally the uterus is greatly enlarged, its circulation increased, and the cervix is more or less encroached on, but the range of variability is large, depending chiefly on individual peculiarities. Any abnormality may become serious, whether of the walls, by attachments; of circulation; or of cervix, and one has to be constantly on the alert to detect such conditions and to properly judge of their potential and actual significance in the given case. It is quite as bad to overvalue some striking change as it is to ignore some apparently insignificant but really potent one.

Fibrosis, muscular distrophies, cervical scars, vascular disorders, adhesions, tumors, or other actual diseases must be given their true value in this complex problem.

(7) The **corpus luteum** of pregnancy should not be mistaken for the clot-filled cyst that follows ordinary ovulation.

I am satisfied that some of the excusable doubt regarding the different characteristics of the two has arisen through ignoring the fact that abortions have occurred.

I was myself much puzzled in the case from which the photographs here shown were taken by finding several of these bodies that appeared to be characteristic. The matter was finally cleared up by obtaining the history of several recent abortions corresponding in time with the calculated ages and conditions of the bodies found. The true corpus luteum resembles the suprarenal body in the peculiar orange yellow of the outer layer, and this is not like either a yellow fibrin clot, nor is it like one where the hemoglobin has decomposed, for in such the iron salts leave the buff color of iron-rust. Preserved specimens, however, are less striking, which may account in part for the stand of certain

eminent anatomists. I have never failed to find them in pregnancy. After the end of the first month one can be reasonably sure of their nature. In pseudopregnancy they are possible, at least for a time. In the vast majority of cases they are easily found, and are so clearly marked that no doubt can exist, though at times they are poorly developed. Their chemical significance is beginning to be understood and is most important and interesting.

(8) **Diseases of pregnancy** group themselves naturally into those pre-existing in the parts, those resulting from the condition, diseases of the fetus, and grave general diseases. Of the pre-existing disorders of the parts, various forms of metritis, endometritis, salpingitis, and ovarian disorders at once suggest themselves; to these must be added serious mechanical conditions, such as adhesions, lacerations, displacements, and growths.

Of the disorders consequent on pregnancy, the most common are those of heart, kidneys, and digestion, though any organ or system may give way under the strain, and such breaking down may react on the pregnancy.

Diseases of the fetus, aside from injury, are chiefly secondary to some condition of the mother, but the enormous number of fetal deaths make it necessary for us most carefully to consider the many problems of congenital defect and weakness, aside from clearly apparent disease. Poisoning of the fetus *in utero* is a large subject, far too seldom considered. Alcohol, lead, opium, and coal-tar products are well known as fetal poisons, but many others are given to pregnant women with strange disregard of the consequences. Many of the general and some of the special diseases in the mother produce either toxemia or direct infection in the fetus.

Death of the fetus before that of the mother is generally easily told by the postmortem changes found.

(9) **Abortion.**—So great is the strain put upon the constitution of the mother to furnish food and air, to remove waste products, to resist mechanical disturbances, and develop or neutralize the many chemical substances incidental to growth, and to develop lactation and actually carry a child, that we marvel so many succeed with their handicap of bad health, bad habits, and ignorance; add to these the actual diseases that tend to prevent conception or interfere with pregnancy and the accidental diseases intercurrent, and there is small wonder we have such an enormous list of natural abortions.

Where so many causes may bring about a condition the problem of finding the true cause at a postmortem is certainly a difficult one.

The problem varies with the type of the mother, being different for the weak and the strong, the sickly and the healthy, until we become convinced that no factor can be ignored. The teamwork done by the organs and tissues of the body during pregnancy may or may not leave clear marks and signs to be read at the postmortem, but these should be looked for. Abortion may follow any of the diseases of pregnancy, either singly or in combination, but the finding of such a disease is not

proving that such was the cause of the abortion unless such condition was clearly of the nature or degree to necessitate it. This we must assure ourselves of at the time so far as possible.

Causes of abortion may be grouped under two main heads—internal and external. Each of these contain subgroups of mechanical and chemical. The internal also contain a third or biologic group, and a fourth or pathologic.

Some women naturally abort without apparent reason. At the postmortem we may find increased muscular development of the uterus, some condition of the endometrium, a laceration of the cervix or tumor in the wall, or some mechanical defect or peculiarity, or the blood-vessels may be defective, as in syphilis. At other times we are forced to consider the internal chemistry, and then we must look into the condition of the secreting, excreting, and internal glands, the factors of physical development and condition, of habits of life, of food, stimulants, and drugs. The fact that abortions are most frequent at the time menstruation would have occurred is not to be forgotten, for it holds biologic factors, both mechanical and chemical, of the greatest significance.

The ages of both parents may have some influence. One must never forget that women are very apt to hide the truth or tell what is not true about this, and that what is proclaimed as a natural abortion is not rarely an induced one, and that in some women drugs are effective and are habitually used. It is, therefore, not an easy problem to solve.

The question not rarely arises, Did the woman abort?

We must be sure not to mistake a uterus in the later stage of menstruation for one recently emptied of a fetus. Generally this is easy, because in pregnancy the placental attachment is clear, the uterus is markedly enlarged, the lumen is even more noticeably expanded, the cervix shows a tendency to soften, the corpus luteum is characteristic, and some signs of pregnancy remain. The longer the pregnancy has existed, the easier it is to determine its existence.

In the first few weeks of pregnancy the signs given are of little value, and if the uterus is emptied at this time there may occasionally be a doubt, specially if the use of the curet has been skilful in avoiding violent scraping, and has been successful in removing the placental attachment. The size of the os may help us for the first few days after abortion, but in a young muscular uterus the reaction is often rapid and nearly complete. If the woman has lived some days since the abortion the type of the organs must be carefully considered as a factor in restoration, which is at times rapid. In chemically induced abortions, scars and marks of violence are generally wanting, but in those by violence many sorts of marks may be found which quickly settle the whole question.

There are many real problems which one meets in a large practice that are troublesome, such as, How far was pregnancy advanced when abortion occurred? This is generally not difficult to estimate roughly after the third month, always remembering that restoration varies greatly and is impeded by complications. When the abortion occurred? which, in a measure, forms part of the former question.

What was the means employed, if not spontaneous? This is seldom clear, and a too definite answer is not to be made. What complications existed before and what have arisen during or after the abortion? These require great caution, because one must judge the ages of the findings accurately in order to determine when the abortion occurred and when each complication commenced. At times the history points to several operations, and it is then desirable to group the various stages of the development of complications. Infections may have resulted from previously existing disease or by the introduction of the germ at any stage or by extension. The rate of spread of infection varies with the virulence of the growing organism, with the resistance of the part, and with the damage done to the parts, as well as with the foreign matter present, which includes blood and tissue.

Labor, or the separation of the fetus after the seventh month, presents many complications which may directly or indirectly lead to death. The birth canal generally shows signs of violence due to extreme pressure and dilatation, which depend on the proportion between the size of the fetus and the canal, as well as the previous condition of the tissues. Frequently severe, and not rarely fatal hemorrhage complicates the process; this may precede or follow delivery, and its source is to be determined as well as its extent and effects. Serious ruptures or lacerations may produce not only hemorrhage, but shock, and may open paths for infection.

Such evidence of violence is generally clear and easily interpreted, but if the woman lives some days these signs may be masked by subsequent changes.

The separation of the placenta and membranes may be delayed for a long time, leaving material which may seriously modify the normal progress. Exhaustion and relaxed tissues may prevent the proper normal recovery for surprisingly long periods, so that false conclusions and mistakes can easily be made by one not alert. The amount of fluid within the sac may cause paralysis by distention and retard contraction.

Labor, being the culminating strain of pregnancy, frequently causes the breaking down of distant organs, at times immediately, at other times after some days. The mechanical, chemical, nervous, circulatory, and excretory recovery may be delayed or blocked so as to give rise to serious or fatal complications. Chronic diseases of the heart and lungs are often very seriously affected by pregnancy, and at times the effect appears most serious after labor.

Many of the disturbances of pregnancy rapidly disappear as soon as the fetus is discharged, but at all times it is important to study the organs that have been burdened, with regard to the extent of the effect on them by the pregnancy. The elements of strain, exhaustion, and shock must be carefully considered as influences where lesions are found in any organ. The lochia help us to interpret many local findings.

The puerperium has a physiology, pathology, and hygiene of its own which in normal, robust women give us little concern, but in all phases of abnormality render our task difficult.

INFANTS

The **newborn** infant comes to the postmortem operator for various reasons. In large cities many are abandoned by their mothers, and when they arrive at the morgue very little history is known. Such infants may be premature, but of an age compatible with independent existence, or they may be underdeveloped or imperfect, and, therefore, unviable. Some have been born alive, others were still-born. The problems, therefore, presented by such infants are far from simple ones, and there is a possibility that some crime has been committed, which makes it the more important that care and judgment be used in all such cases.

Certain questions, regarding time of birth and death, condition, and development, and what has occurred since birth, must be answered as fully and clearly as possible. All matters of significance regarding the maturity, perfection of development, viability, and diseases are to be considered with any evidence of violence, neglect, or exposure. In private practice or at hospitals one seldom meets with these problems, but others, as to why the child was not viable, are equally difficult. We shall classify all infants in which the cord has not naturally separated as newborn.

In all cases where crime is suspected it is necessary to establish the *identity* of the body. This is often difficult. Where the infant has been abandoned in a public place the best that can be done is to establish its identity as the infant found on such a day, at such a place by witnesses who found it or helped to remove it to the morgue.

Generally the police are notified when such an infant is found, and they take charge of the body and can identify it in this way. If the body has been found in a residence or other private building, further identification can often be obtained by persons to whom the mother is known.

Servants in families not rarely, and boarders frequently, are known by some one in the house to be pregnant. As these persons will have to be called on to testify as to their knowledge of the circumstances, it is often well to have them observe the child before it is removed and note what it is wrapped in. The wrappings of a body may later help to connect the guilty party, but they should be removed carefully, as they may have caused death by asphyxia through suffocation or by constriction of some part of the body.

The **wrappings** or other materials found with the body sometimes give a useful clue as to whom they belonged and as to what has happened to the infant.

If the cord and placenta are still connected with the body, and the whole is bundled up as if in haste, the case is very different from one where evidence is found of premeditated attempt at concealment.

Many children are abandoned to save the expense of burial. This practice is common among the low and ignorant immigrant class. Not a few are disposed of so as to hide the shame of the mother. Saddest of all are the cases where the mother's trouble has destroyed, at least temporarily, the maternal instinct, and she causes the death of her infant. It is a delicate business to determine whether there is evidence which clears such an unfortunate woman of the charge of murdering her infant by establishing reasonable grounds for believing it was an accident which happened during the pains of labor, and it is a serious matter to establish that no such accident occurred, but that some act of violence caused the death of a living and viable child.

While these matters belong to the field of legal medicine, they also come within the duties of ordinary practitioners.

I have been called to investigate not a few cases where physicians have reported that there was grave suspicion of infanticide. Some of these should never have been reported, because the poor woman suffered greatly from the imputation of a crime wholly foreign to her nature.

At other times physicians have overlooked the most flagrant crimes, reporting the cases as entirely free from suspicion. In one case I was severely criticized by a physician because I caused the arrest of a woman whose child had been taken alive from the furnace. It subsequently developed that the woman and the grandmother had intended to burn the child in the furnace in order to cover the mother's shame. One may be surprised at such criticism, but need pay little attention to it.

Everyone, whether engaged in public or private work, must be on the alert for conditions which should arouse suspicion, and when found they should be ready to do the proper thing under the circumstances, and where actual evidence of infanticide is found the proper authorities must be duly notified.

The **maturity** of the infant is to be judged more by the development than by size and weight. In a general way the weight is of assistance, and it may be well to consider the average weight as about 3500 gm. and that the weight may vary from 1200 to 5500 gm. The length of the body averages about 50 cm. The larger is one's experience, the more difficult is it to lay down a rule for size and weight. I rely more on the proportions of the head and body, the position of the umbilicus, the development of hair, nails, and skin, condition of eyes, and the minor and more variable factors of vernix, placenta, cord, meconium, and condition of the bones.

Perhaps the ossification may be considered as a major guide, but I have seen such wide variations in bone development that I am not inclined to lay as much stress on it as are some eminent authors. Still it should not be neglected, because the variations are often caused by conditions and diseases which form part of the study of the case, and after such study has been made the estimate of the variations can be corrected so as to give much more definite data as to age. I believe it

better to determine the conditions, and base my approximation as to age on all the findings.

The **time of death** is to be determined with relation to two periods—the birth and the time of the examination. This may be a difficult matter, and is never as simple as it seems to those who lack experience. The child may be born alive and remain alive for a short period, if the

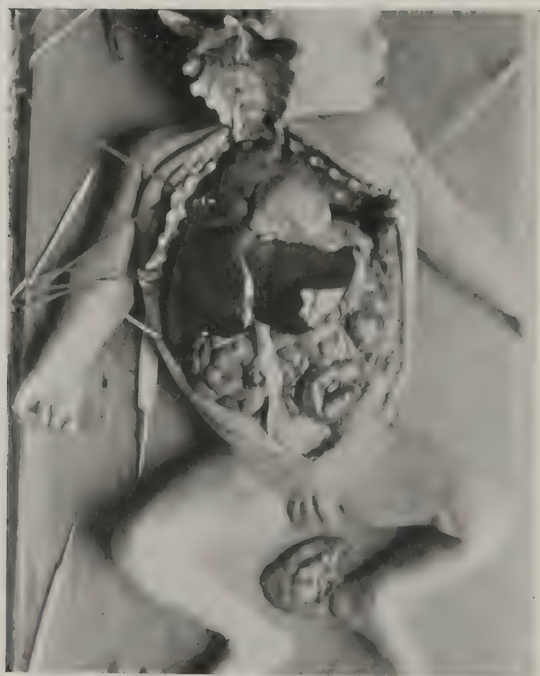
Fig. 233.—Infant. Series 1, A.

A newborn infant, born dead and abandoned on the street. All of this series are from this case. The skin-flaps have been reflected, leaving the peritoneum intact with the umbilicus. The lines of the hypogastric arteries are seen running in the peritoneum. The removal of the sternum allowed the study of the belly sac. After this the peritoneum was opened at the sides and dissected away.

cord is intact and the circulation in it maintained, yet never breathe. While this has little significance from a practical point of view, it assumes importance at times. The law measures life by breath in such cases, provided the child was otherwise viable, but, as usual, the legal practice varies.

If the child's lungs are not expanded it is still-born, even though it may have been very much alive as it emerged from the birth canal.

Birth consists not simply in delivery, but in setting up independent existence, and this implies respiration apart from the placenta. In determining whether the child has breathed, one must ascertain whether the lung has expanded and how much. The presence of a little air may simply indicate that artificial respiration was practised. The presence of gases of decomposition in the lungs will cause them to float, but one should be able to determine by simple inspection, and certainly after



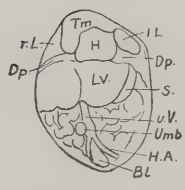


Fig. 234.—Infant. Series 1, B.

The organs are practically normal, and the lungs are atelectatic and dark. Note the method of retraction by means of string caught on screws set in the dissecting board.

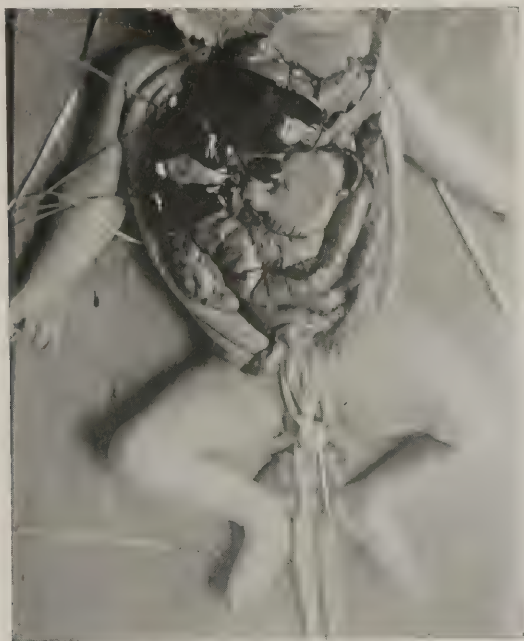
Bl. Bladder. *Dp.* Diaphragm. *H.* Heart. *H.A.* Hypogastric artery. *r.L.* Right lung. *l.L.* Left lung. *L.v.* Liver. *S.* Stomach. *Tm.* Thymus body. *Umb.* Umbilicus. *u.V.* Umbilical vein.

palpation and sectioning, whether the lungs are expanded or not. The floating-in-water test is a harmless proceeding of moderate value.

The **viability** of an infant is not a simple problem, and must always remain in doubt unless positive signs exist which show that the child could not have lived. The legal supposition is that a perfectly formed child which shows no condition which prevents it from living is viable, but this is coupled with a well-established rule that no one can be charged with injuring the child unless there is positive evidence that it lived. Many children are unviable for reasons which are not apparent at the

postmortem examination. Many are rendered unviable by the occurrences of labor, some from exhaustion, others by shock, many by asphyxia. When actually injured during labor there are usually marks or signs of such injury, and these must be clearly understood, else they may be confused with other forms of violence.

The history of the pregnancy and of the delivery will always be of value, as will a knowledge of the condition of the mother. Sometimes the placenta and cord show the cause of the death. Hemorrhage from



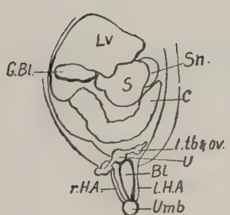


Fig. 235.—Infant. Series 1, C.

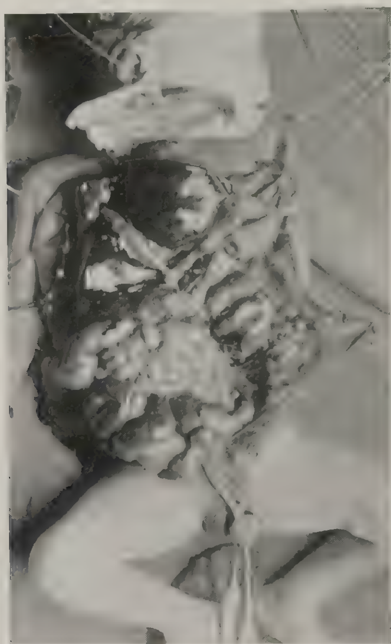
The liver has been turned up, showing the relations of the stomach, duodenum, and gall-bladder. The colon is filled with meconium. The umbilicus is retracted, showing the sexual organs.

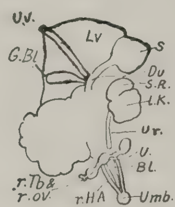
Bl. Bladder. *C.* Colon. *G.Bl.* Gall-bladder. *H.A.* Hypogastric arteries. *l.* Left. *r.* Right. *Lv.* Liver. *S.* Stomach. *Sn.* Spleen. *tb.* & *ov.* Tubes and ovaries. *U.* Uterus. *Umb.* Umbilicus.

the cord is far less common than one would infer from the literature and reports of examinations.

Conditions may exist in the infant which will surely prevent life after delivery. The commonest, at least in my experience, are those affecting the air-passages. It is very common to find an inflammatory condition of the trachea and bronchi where a tenacious, usually yellowish mucus fills the lumen, and is so adherent and has such a high degree of cohesion that it would be impossible for the child to dislodge it. I

have tried various methods in attempting to dislodge such mucus. The only one that would be applicable as a restorative measure is so rough that it would be likely to cause serious damage. It consists in rapidly binding the belly tightly, leaving the cord free, and then, with the child inverted, to smartly compress the chest with both hands, the finger-tips being at the spine and the thumbs along the sternum. A small number of otherwise doomed infants would be saved by this method. Sometimes one meets with cases where a little attention to





Bl. Bladder.
Du. Duodenum.
G.Bl. Gall-bladder.
H.A. Hypogastric artery.
K. Kidney (*l.* Left. *r.* Right).
Lv. Liver.
S. Stomach.
S.R. Suprarenal.
Tb. & *Ov.* Tube and ovary.
U. Uterus.
Umb. Umbilicus.
Ur. Ureter.
U.v. Umbilical vein.

Fig. 236.—Infant. Series 1, D.

The stomach is retracted to further show the duodenum. The colon with the peritoneum is moved to the right to uncover the left kidney and suprarenal body. The small gut is pale, contracted, and empty.

the collection of slime in the pharynx would have saved the child's life.

I firmly believe all those who attempt to deliver babies should carry well-rolled gauze sponges about $\frac{2}{3}$ inch in diameter, to be used with stout hemostats to swab out the pharynx before and during artificial respiration.

Pinching of the cord before the child has a chance to breathe has caused many deaths. Shock appears to be responsible for some fatalities, but very young children seem to resist shock in a remarkable way. A vast number of children die from asphyxia, some few of heart disease.

Infants are very sensitive to certain drugs taken by the mother, such as opium and lead. From birth onward as well as at birth the

formation of tenacious mucus in the air-passages is a serious matter, and this is a far more frequent cause of sudden death in children than would appear from a study of the literature. Violence to the head is endured with remarkably slight effects in the majority of instances, so that one must be cautious in attributing death of the newborn to this cause. Detachment of the placenta before the child reaches the air is an occasional cause of asphyxia that should be considered. Occa-

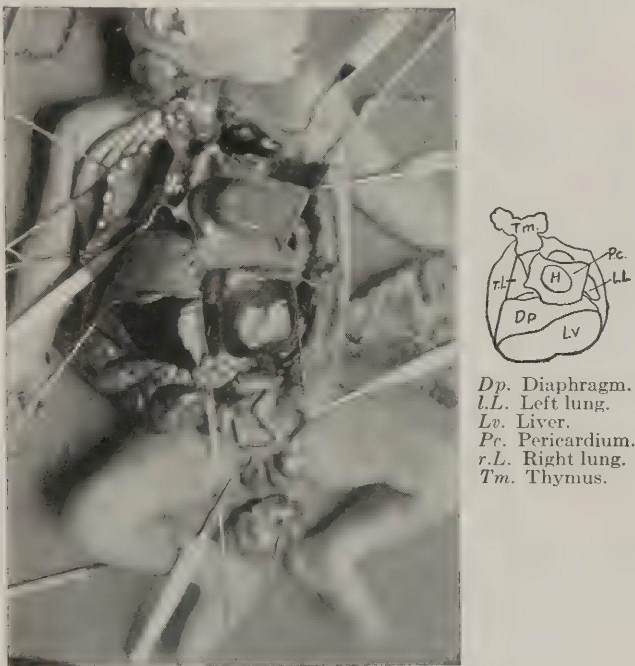


Fig. 237.—Infant. Series 1, E.

The umbilical structures are separated. The liver drawn down by strong traction on the diaphragm. The pericardium opened and showing its translucency. The heart is contracted and somewhat injected. The condition of the right lung is better shown. The thymus has been freed and turned upward. This series shows incidentally how much can be demonstrated without loss of blood.

sionally one meets with some anomaly which may prevent the infant from living long, and rarely these are of such a degree as to cause early death; only in the rarest cases are they of such a nature as to prevent the child from living a few days.

The **cord** is the means by which the fetus receives its air and food from the mother. At birth it is usually a little longer than the infant's body, but varies greatly. It is peculiarly twisted, the turns are usually few in number, but may be greatly increased. These turns form a sort of spiral spring, which prevents many accidents which would more easily occur in a straight organ. The significance of the number of turns is not always clear, but when the vessels are tortuous and the placenta fibrosed definite conclusions are easily drawn. The twisting begins about the

third month. Anomalies of the cord, either in the vessels or by mechanical means or from disease, should be noted.

The insertion of the cord in the placenta varies, being often to one side of the center. This seems to depend on the position in which the placenta is attached to the uterus; of its significance, either as to cause or effect, we know little. The fresh cord is elastic and resists traction, but this varies so that when it is found torn it is necessary to test its tensile strength in order to determine the amount of force used in making the original break. After birth it dries rapidly and separates in a few days; during this period it may become infected, causing death by sepsis.

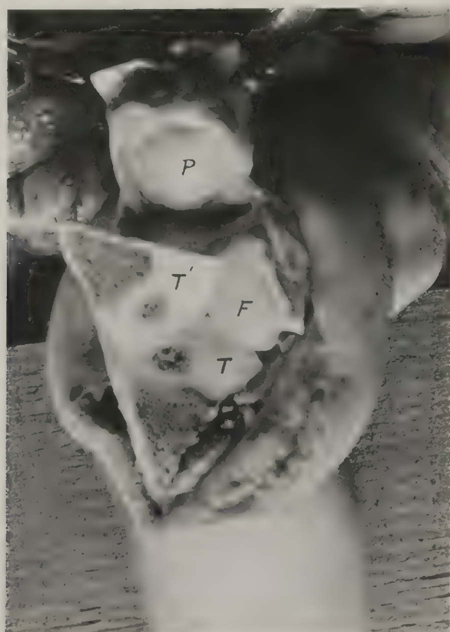


Fig. 238.—Tibia Sectioned in Newborn.

A longitudinal cut, slightly curved, displays the patella, which is loosened from below and reflected. The leg is grasped with the free hand while with the knife thin slices are removed from the tibia from below upward and slightly backward. *F*. Femur. *P*. Under surface of patella. *T*. Tibia. *T′*. Slice.

Diseases of the fetus are described in the works of obstetrics, but are not extremely common. Occasionally the disease is shared with the mother, and manifestations are found either on the surface or in the mouth, eyes, or internal organs.

Syphilis is oftener diagnosed by the results on the bones and liver than by acute lesions, though these are common enough to be fairly well known and easily recognized. Normally, the liver of a newborn child is very large, and if the child is small this disproportion seems even greater. The liver is not infrequently engorged with blood, and this still further misleads the observer as to the actual size.

Icterus may occur without syphilis. Not all sores are due to syphilis. The condition of the blood-vessels in the placenta is often the only finding which suggests this disease, though the growing portion of the long bones is very apt to show the characteristic disturbance. The general appearance of the infant is frequently characteristic, being best characterized as old looking. Marks of violence due to delivery are common, and while not in themselves a disease, they not infrequently lead to serious infections that are often overlooked at the postmortem.

Postmortem changes take place rapidly in infants. In the body of the mother they may be simply those due to maceration. Where the uterine contents are sterile (free from saprophytic forms) the fetus may remain for some time in the uterus after its death without giving rise to serious signs or symptoms in the mother, and on delivery will show varying degrees of change, depending on many factors, the amount of vernix caseosa being one of the more important ones. The tissues will be more or less soft and jelly-like, and the color of the blood and tissues will be changed.

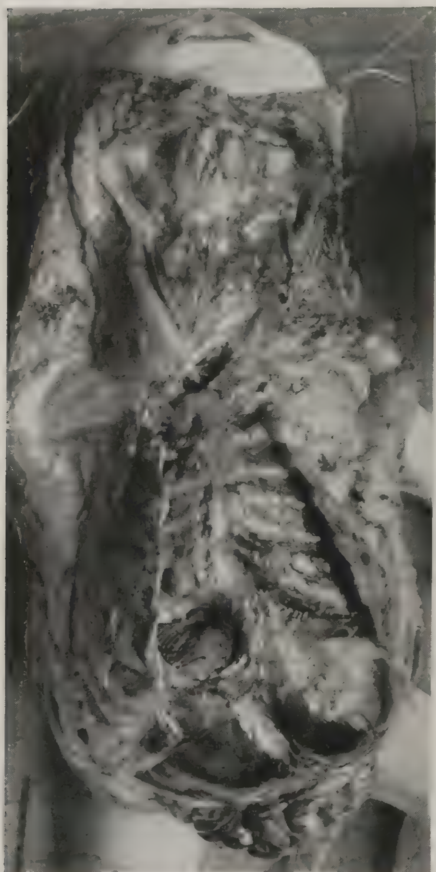
One should be cautious in saying just how long the infant has been dead in the uterus. Outside the uterus, where the saprophytic bacteria have ready access to the body, and where the changes of the surface tend to give ready entrance, the process is much more rapid than in the adult, but depends on the same conditions of heat and moisture and also varies greatly with the individual. Adipocere forms quite readily in the bodies of infants. There are few cases where gases accumulate in the body. There being little fibrous structure and no resistant parts, the body presents more marked and general softening.

The **dissection** of the newborn is a much more delicate piece of work than an ordinary postmortem and requires finer instruments. The parts are so much thinner and more transparent that the eye is able to see more without any cutting. The bleeding is free and difficult to control, so that cutting should be deferred as long as there is anything to be seen without it. The problems are different throughout, because there is little of the usual chronic change to be found and the organs have not been subjected to unnatural strain, some of the organs not having begun to functionate. The internal glands are all oversize except those which later assume the sexual functions, the stomach contains a little slime or possibly some recently swallowed matter. The processes of digestion have not yet started, except that the liver is secreting bile. The intestines are empty and contracted above, and at birth the lower segment contains more or less bile-colored meconium. The figures show the organs and how to reach them. The circulation through the cord is also shown. The incomplete heart is occasionally met with, and this is dissected in the way directed for ordinary routine work.

The brain is best reached by making the usual skin incision across the top of the head, and then either by sawing or with stout shears opening the skull. In opening the skull any one of a number of cuts may be made, depending on what special dissection or investigation is contemplated. As a routine method I prefer to separate the two parietal

bones with scissors or the knife point, in which case I introduce the point of the blade just through the dura, holding the edge outward, and carefully push the point forward; the bones when freed can be bent outward so as to give free access to the brain.

In order to remove the brain through this opening the parietal bones are strongly retracted by strings. This method permits repair of the



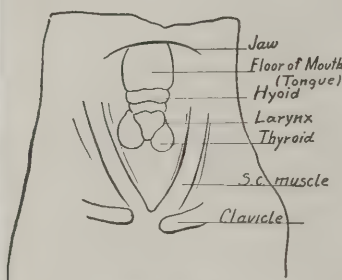


FIG. 239a.

FIG. 239.—INFANT. Series 2, A.

The primary cut has been carried a little above the suprasternal notch. The skin-flaps have been fully reflected, and the upper part has been drawn forcibly upward by two strings. The floor of the mouth is seen with the groups of muscles and the superficial veins. By comparing with Fig. 240 the relations of these superficial structures to the organs of the neck can be readily made out.

head afterward, which is difficult after any of the other methods. The brain is very soft, and requires very careful handling, and this can best be done under water or normal saline solution, the surface having first been thoroughly inspected. The tissues are so recently organized and built up that no process found can have existed more than a

few months. Few of the specialized tissues other than the heart and blood-vessels have been functioning. The processes have been vegetative and chemical; the nervous paths are open, but in a still primitive condition. Of the brain physiology we know practically nothing.

The skin and mucous membranes may show irritations or may share in general infections. The chemical organism is extremely active in

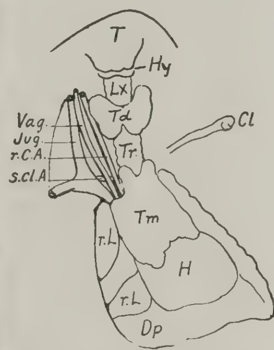


FIG. 240*a*.—*Cl.* Clavicle.
Dp. Diaphragm.
H. Heart.
Hy. Hyoid bone.
Jug. Jugular vein.
Lx. Larynx.
r.C.A. Right carotid artery.
r.L. Right lung.
s.cl.A. Subclavian artery.
T. Tongue.
Td. Thyroid.
Tm. Thymus.
Tr. Trachea.
Vag. Vagus.

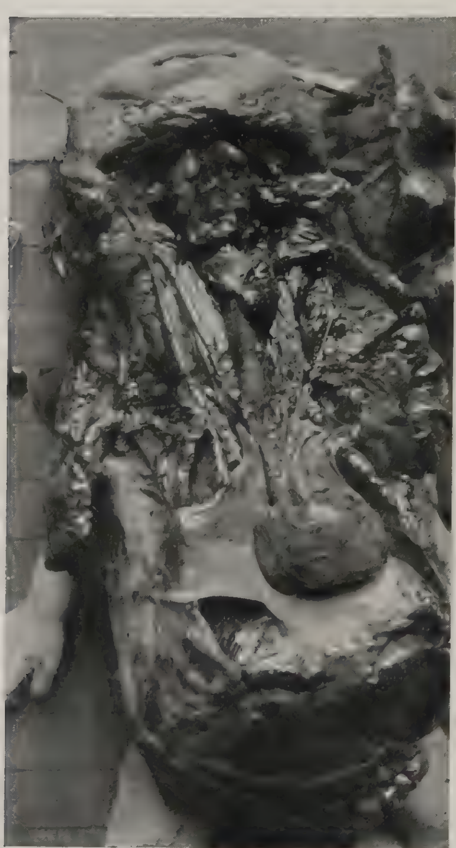
FIG. 240.—INFANT. Series 2, B.

The superficial muscles have been removed, the sternum cut away, and the clavicles turned outward. The relations of the neck and thorax are well shown. The base of the right lung is markedly congested.

maintaining the blood in a suitable condition for rapid cell growth and reproduction. Internal irritations are found in the lateral ventricles of the brain, and in the deepest parts of the mucous membranes of lungs and urinary apparatus. The problems are so widely different from those found in adults as to entirely baffle those whose training has been limited to problems in the full grown. They are intensely interesting, but often very difficult with our present knowledge of biochemistry, for the problems are largely chemical. Embryologic anatomy helps us to know the effects, but not the processes or causes. We are face to face with the

mystery of life, where things are happening which we observe, but do not understand.

Older children begin to present the adult problems with which we are familiar. The circulation changes gradually, but from the start resembles that of the full grown. The lungs suddenly cease to be solid glandular bodies, and take up respiration, but the records of studies of sudden deaths of children show that too little is comprehended of the



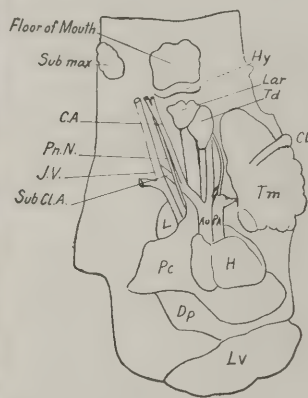


Fig. 241*a*.—*Ao.* Aorta.
C.A. Carotid artery.
Dp. Diaphragm.
H. Heart.
Hy. Hyoid bone.
J.V. Jugular vein.
L. Lung.
Lar. Larynx.
Lv. Liver.
P.A. Pulmonary artery.
Pc. Pericardium.
Pn.N. Pneumogastric nerve.

Fig. 241.—Infant. Series 2, C.

The right side has been dissected away so as to make clear the relations and for comparison with the left side. The thymus is reflected and the pericardium opened. The infantile type of heart is quite striking. It is seen to be contracted, injected, and shows several small superficial hemorrhages.

peculiar sensitiveness of the parts, specially to sudden determinations of blood, as seen in croups, catarrhs, and congestions, which yield to counterirritation and hot baths in a way quite different from what we find in adult life. The internal glands must fall behind in their growth or infantilism persists, which should show us the significance of the chemical problems of child life. The special secretions begin to be

developed. Infections invade the mucous membranes specially, and show typical reactions with great variability of resistance, which is usually associated with what is the beginning of what we call type in the adult. The bones show inherited dyscrasia markedly. The whole body is very sensitive to chemicals that directly join with or affect protoplasm. It is entirely futile to attempt to understand child pathology from specimens alone.

The biologic problems far transcend any morphologic considerations. When the form has been established we can with some justifiable com-

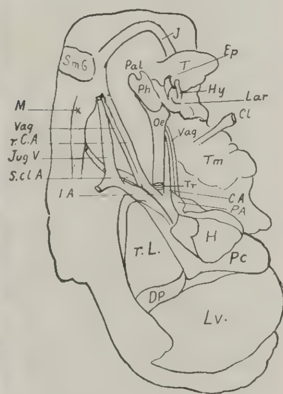


FIG. 242a.—*C.A.* Carotid artery (*r.* Right).
Cl. Clavicle. *Dp.* Diaphragm.
Ep. Epiglottis. *H.* Heart.
Hy. Hyoid.
I.A. Innominate artery.
J. Jaw. *Jug.V.* Jugular vein.
L. Lung. *Lv.* Liver.
M. Reflected muscles.
Oe. Esophagus.
P.A. Pulmonary artery.
Pal. Palate. *Pc.* Pericardium.
Ph. Pharynx.
S.cl.A. Subclavian artery.
S.m.G. Submaxillary gland.
T. Tongue. *Tm.* Thymus.
Tr. Trachea. *Vag.* Vagus.

FIG. 242.—INFANT. Series 2, D.

The dissection is carried to the spine, opening the mouth. The trachea, being severed at the isthmus or base of the neck, is turned to the left side. The right lung is pushed back and the heart drawn to the left. Throughout the series a block under the body has raised the neck and allowed the head and abdomen to fall backward.

placency discuss the relation of structure and disease, but pathogenesis in children is so clearly a matter of interaction of forces and tendencies that even the ordinary physiology of the parts is entirely insufficient. There is too much of latent possibilities, both of health and disease, of which we can only obtain the faintest indication at the postmortem, and the history helps us less, even when it includes that of the family, than

in adult cases. We never can tell what the dominating plan is which has been waiting to influence the development until some critical period brings it into action; nor what factors make up that critical period or condition.

We are forced to admit that postmortems on children impress us with our profound ignorance of much that is fundamental to the

Fig. 243a.—*Bl.* Bladder.
P. Peritoneum (*l.* Left. *r.* Right).
H.A. Hypogastric artery.
Umbil. Umbilicus.
Urach. Urachus.
U.V. Umbilical vein.

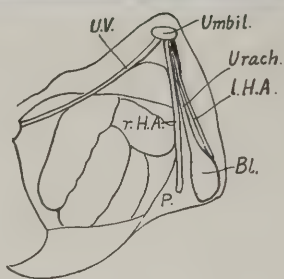


Fig. 243.—Infant. Series 3, A.
This infant was several weeks old, but shows the arrangements of *fetal circulation* clearly.

biology of health, development, and disease. Instead of discouraging us, it should drive us the more to thoroughly master what can be grasped, and strive to extend the conceptions centering about child life.

Chemical Problems.—The food of infants is a very common cause of death. I have frequently been able to tell what sort of food the child has had simply by looking at the body. The pictures presented

by children in which either an excess or a deficiency of sugar, nitrogen, or fat has been marked show the effects quite clearly.

It is difficult to describe these qualitative changes, and it is best to carefully compare the conditions found with the history, taking special care to note the amounts of each substance in the food and the length of time given, and being careful to collate with this any digestive disturbance or intercurrent disease. It will be found that sugar gives a peculiar watery pallor, with a dusky pale buff tint; that fat gives a whiter, plumper look, with often very little blood in the body; while nitrogen disorders frequently give emaciation, with more or less marked odors about the body, though butyric odors may occur in fat indigestion.

FIG. 244.—INFANT. Series 3, B.

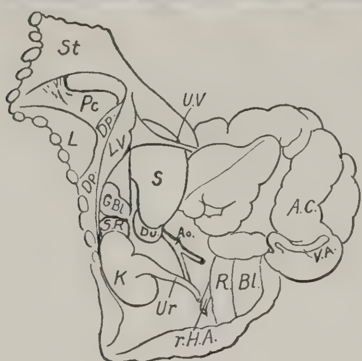
Strong traction exerted on the umbilicus brings into prominence the double ligament which supports it, one part going to the pubis, the other to the liver and diaphragm; in these are included the vessels. The sternum is cut loose only on the right side and bent toward the left, showing the relations of the pericardium. The intestines are empty, but for gas and a little slime.

These are very rough indications of the lines along which observations are to be made rather than an attempt to finish this extremely delicate and curiously neglected subject.

The child is extremely sensitive to certain substances not usually regarded as poisons. Thus, one can hardly mistake the peculiar chalky appearance in children who have had too much magnesia. So, too, toxins generated in the gut by fermentations, or absorbed from the urinary tract when infection has traveled up from the exterior, give tints and shades of varied colors, change of elasticity of skin, rashes, or roughnesses. Tooth-rashes with digestive disturbances must be grouped under chemical causes by reason of their type. Though the nervous

symptoms attract our attention, we must not forget what nervous disturbances will do to disarrange the chemistry of the gut as well as of excretion.

Many catarrhal conditions depend on the absorption of substances which are formed in the gut by fermentation, or from badly adjusted



A.C. (& *C.*). Ascending colon.
Ao. Aorta.
Ap. Appendix.
Bl. Bladder.
Dp. Diaphragm.
Du. Duodenum.
G.Bl. Gall-bladder.
K. Kidney.
L. Lung.
Lv. Liver.
Pc. Pericardium.
r.H.A. Right hypogastric artery.
R. Rectum.
S. Stomach.
S.R. Suprarenal.
St. Sternum.
Ur. Ureter.
U.V. Umbilical vein.
V.A. Vermiform appendix.

Fig. 245*a*.

Fig. 245.—Infant. Series 3, C.

The liver is turned upward, the head of the colon with the peritoneal attachments are turned to the left.

proportions of usable food components. The curd of milk, which is often found in the gut, is one of the commonest causes of disorders of this type, and its presence in an unusable or spoiled condition may lead to either nitrogen starvation or poisoning, without regard to the total quantity taken.

Convulsions as a cause of death are so frequent that the term has been regarded as objectionable, and after the age of three months we are required to give some contributing cause. There was formerly a tendency to regard the mechanical results of food as important in producing convulsions, but more recently the tendency has grown to consider the chemical effects associated with the mechanical conditions. This tendency has not yet carried us far enough, for even today we are underestimating the chemical side.

We must not neglect mechanical irritation of any part of the body, and at the postmortem any evidence that is discovered of it should be most carefully considered. There is almost always a disturbance of the

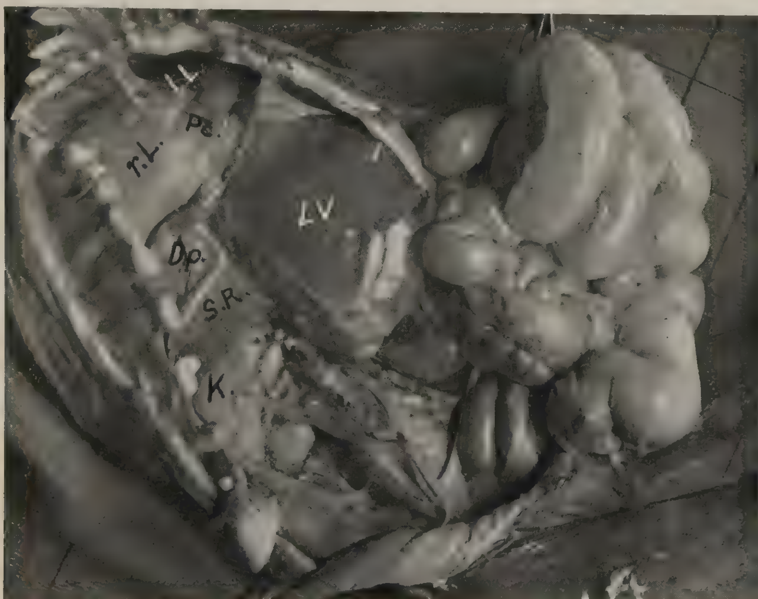


FIG. 246.—INFANT. Series 3, D.

Dp. Diaphragm. *L.* Lung. *Lv.* Liver. *K.* Kidney. *S.R.* Suprarenal. The liver has been turned to the left side, giving free view of the relations of the diaphragm and suprarenal. Note the translucency of the small bowel; also how the hypogastric artery joins the internal iliac.

normal distribution of the blood in these cases, and if possible we should determine from the history and the findings any reason for this after carefully observing it. There is usually more or less contracture of the hands, and at times of the arms and legs. Such contractures are always serious. There will still be a rather small percentage of cases where the convulsions are wholly due to some condition of the nervous system, though this system frequently acts by reason of poison or irritation.

Infections.—Most frequently of the contents of the gut, with or without enlargement of the glands of the mesenteries, often with involvement of the lower half of the gut itself, not rarely with a follicular condition. Perhaps as frequent, but not as often to be noted, are the

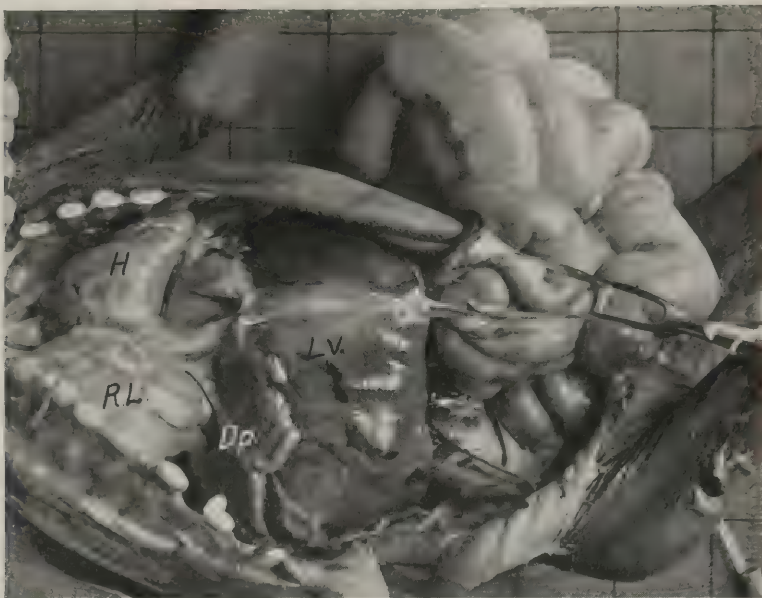


FIG. 247.—INFANT. Series 3, E.

The liver is drawn downward, carrying with it the diaphragm, as in inspiration. The kidney is completely covered; the pericardium being opened, and the heart is seen to be contracted. The effect of tension from below is well shown. The heart is not rotated downward because the pericardium no longer presses on it in front.

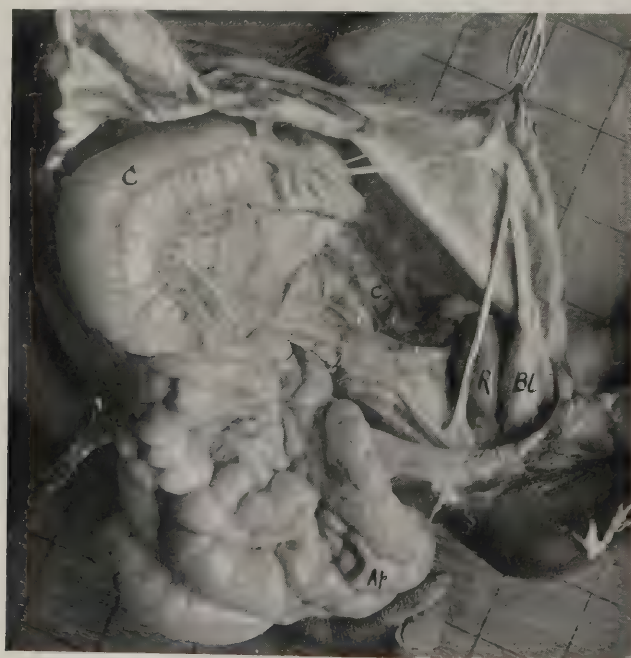


FIG. 248.—INFANT. Series 3 F.

The small gut is turned to the right and the transverse colon upward. The glands in the mesocolon and mesenteries are clearly shown. The remains of the hypogastric artery and urachus have been dissected. The child from which this series was made had been fed on spoiled milk, but finally not fed at all, and died of criminal starvation.

invasions of the nose, throat, and mouth. Many of these escape detection both in life and at autopsy. Glandular enlargements in the neck imply serious or prolonged infection. The lungs frequently show bronchial catarrh, which may be so severe as to cause an occlusion pneumo-

FIG. 249.—The liver has been turned upward, and the whole mass of the intestines has been removed with the attached folds of peritoneum, and is placed on a glass plate for study of details. The masses of glands in the mesenteries show a general enteritis. The stomach and duodenum have been opened, and their relations to diaphragm and liver are clearly shown. The kidneys, ureters, and great vessels are seen below, and the retroperitoneal glands show that they are involved as a result of the extension from the mesenteric lymph-channels following the enteritis.

nia. Vasomotor disturbances, from whatever cause, give rise to congestion or stasis, which too frequently is combined with a bronchitis, and is often incorrectly classed as a pure pneumonia.

I seldom see true typical pneumonia, but very often a bronchitis with secondary congestion. Typical edema of the lungs is rather rare.

Skin infections differ from those in adults chiefly by reason of the differences in the skin. Umbilical and urinary infections are far from rare. These have already been referred to. Brain infections are, as in the adult, serious, but show rather less at the postmortem than the symptoms would lead us to expect.

Trauma in children requires the same careful study of the textural qualities of the injured parts as in adults, though the textural, tensile, and architectural problems are very different. Internal injuries with hemorrhage are more readily received and are apt to escape clinical observation. I have examined many cases where clinical observers have failed entirely to adjust their minds to the peculiar problems of child architecture and tissues. Crushes of the viscera may be extremely severe, owing to the slight protection by bones and the delicate texture of the parts, with but little external evidence of violence. Bumps and swellings are apt to form and fade quickly, and the discoloration is generally less marked than in adults. Shock seems to be much better borne by children than by adults.

BONES

THE study of the bones formerly received a far greater consideration than it does at present. This was for a long time the only permitted form of postmortem on the human body.

Out of the painstaking study of dead bones came but a very limited amount of useful science. Even in craniometry, where the many variations and types were described, there was but little gain made, because too little attention was paid to the reasons why such variations came to exist.

If we would avoid such futile labors in the future, we must shun the unenlightened method of the descriptive anatomist, and must strive to take the broad, comprehensive view which considers structure as a means to an end, as a product of vital forces acting under purpose according to laws, and not a subject for isolated consideration.

There is great need for a revitalized osteology, and since the *x*-ray has become so accessible there is greater hope that this very practical need may be met.

The function of each peculiarity must be studied intelligently, and these various functions should be grouped in a natural way. Thus, we find support, protection, and mechanical ends served often by the same bone, and whenever we consider any bony structure we must keep these three functions in mind.

That the bony skeleton represents the resultant of all the nutritive functions and inheritance, as well as defect, habit, and disease, must not be forgotten. The relation of general health and disease to bone production, reconstruction, secondary change, and disease is intimate.

Now that we are finding out new functions for the bone-marrow in relation to blood-cells this relationship is assuming a new interest. Nor are we any the less alive to the significance of bone conditions since the connection between internal secretion and bone development has been positively demonstrated. We have long known that the bones of the insane are apt to show marked peculiarities aside from specific infectious diseases, which have an independent set of results. Syphilis and tuberculosis of the bones develop in a certain proportion of persons infected with these diseases, but as yet we have given too little consideration to the reasons why the bones are affected in only certain types, though the infections are apparently the same as in cases where the bones are not so affected.

The craniologists classify men into types by the peculiarities of the skull, and their work will again assume an important place in practical medicine, though at present it is little considered outside of neuropathology.

The method of using dried bones for study is more or less of a necessity, but it is an unfortunate one, because the vivid first impression made on the mind is hard to eradicate, and one instinctively thinks of the bones in the body in terms of dried bones. This defect can be overcome only with some effort on the part of the student.

If I were to start a student on his studies I would always have a lot of fresh bones from the butcher on the table with the dried ones, so that the after-labor of those students would be less painful, and their resentment at having to unlearn and relearn so much would be in so far reduced. I find it a great help even now to drop into a butcher's shop and study fresh bones, and I heartily recommend the practice to all who take their work in a serious scientific way.

The older medical writers on legal medicine laid considerable stress on the study of the bones for identification, for the determination of sex and of age, and all writers have considered bone injuries from violence as of great importance. There is only one way to understand these problems; that is, by a study of much material in the fresh condition, for which animal bones are useful.

The general size and shape of the body and of its parts depend largely on the condition as well as the development of the bones. The bony structures in a measure influence the organs by reason of their size, shape, and position. This is clearly seen in the great visceral cavities of the head, thorax, and pelvis, and, to a less degree, in neck and abdomen. The reaction of the organs on the bones is seen in the bulging precordia in heart disease, the changes in the pelvis in pregnancy, the ribs in disease of the lungs, and the skull in hydrocephalus. No less striking are the bone-bound brain of the idiot, the rib-bound chest, or the rachitic pelvis.

Most of the striking deformities of the body are associated with bone lesions, the effects of which may be most serious. The primary bone diseases, aside from those connected with anemias, are not very common, but they are striking, and the study of the relation such lesions hold to conditions not only in the bony tissues as a whole, but to all the other organs, is of much vital significance.

Age plays a very important part in the conditioning of the bones. In infancy one finds bone forming in the cartilage as well as replacing it, and these centers of ossification, while showing a generally steady or, at least, progressive growth and change, are affected by diseases and nutritional disorders, of which they may become indices. At maturity these centers have united, and the growth is mainly exogenous and quite limited in normal conditions. As age advances, senile changes appear, and the whole structure undergoes a change, until in the very old the bones are smaller, more brittle, and at times mere shells, as is often seen in the ribs, which then can be broken very easily. Presenility shows itself in these bones. At times one can judge of the age from the condition of the bones; to do this one cannot follow rules alone, but must be always alert for the modifying factors, because the rules are in large measure made from averages, while the case under study may be an

extreme at either limit, or some influence may have retarded or accelerated the average rate on which we are basing our judgment. Age judgments are always better when based on all conditions rather than on any one.

Sex shows a marked effect on the bones. Naturally, this is more marked as the other peculiarities of the sex become more noticeable. The bones in the female are usually less robust, show a smoother surface, with less marked ridges for muscular attachment, and in the pelvis reach their greatest divergence. The bones of the hands and feet are usually smaller, though exceptions are not rare. The skull is usually less well developed, as well as averaging less in all its measurements. It may be characterized as underdeveloped. With these variations of size and development naturally go quantitative and structural differences, which generally are associated with and are produced by the same causes.

A bone expert seldom mistakes the sex of a given bone, though the masculine female may have better development than the feminine male, except in the pelvis, where she always maintains her type, though pelvimetry shows how wide are the variations in this part, the female pelvis being wider and more capacious and the sacrum straighter.

The **architecture** of the bones is an unlimited field because of the different types and of the variations. As a matter of scientific interest the subject is extremely broad and fascinating, but from the practical point of view it is also of extreme importance. It is simply impossible to understand injuries, either to or through the bones, without a rather clear conception of form and substance and the plan on which the building is put together.

It is well to note how the long bones are tufted at the ends which receive violence in order to obstruct, retard, and overcome such force; how the ankle bones are differently planned to meet the jar and destroy, at least, a part of it; how the vertebræ show a still further modification of type, where many layers are grouped in a graded series, and given an added resiliency by reason of a set of gentle curves, which also conform to the requirements of the viscera.

The skull, however, contains the most difficult problems. Each part has a type or style of its own, and yet all these styles are united into a composite which acts as a whole. It is a constant wonder how bits of irregularly shaped bones can perform so many different functions as we find them doing in the skull.

Physical properties of bone vary very greatly, even in the same part of the same bone, and such variations are significant. In youth they show a resiliency or spinginess (sometimes called elasticity, but a very different thing from true elasticity of the physicist, such as is found in ivory). In rickets there is a softer gelatinous type of resiliency. In old age a calcified, hard, unbending, non-resilient type which may be elastic. In disease we may find the bone soft and without either resiliency or elasticity, and either spiculated and breaking like splintery dry wood, or more or less granular. In faulty types there is high

elasticity, but little resiliency, and it breaks into small irregular fragments, like poor glass. In the degenerate type it is thin, fragile, and more or less resilient within limits. In the range of normality it varies from these extremes, and differs greatly in quantity in two ways: (*a*) In total mass; (*b*) in quality. These variations are associated with the biochemisty of the body, and are indices of changes or modifications of the average nutritive adjustments within the organism.

The **methods of examining** bones are apt to be far too much restricted. Simple sectioning may show abnormalities of the cells, vessels, and general histologic structure, but such sections will not show those things which are most important for us to know as the basis for study of effects of violence. There is no other way to arrive at a knowledge of the tensile strength or of the fragility of bone than by properly testing, or subjecting it to such physical forces as produce injuries. Nor can one understand the way bone actually transmits violence unless one has observed the effect produced by the application of force to bone.

The decalcification necessary to prepare bone for histologic work destroys its physical properties. Bone strength is not unlike that of building-mortar, and the microscope is equally useless and unnecessary in testing either.

Bone qualities are noted; first, by the eye, specially the color, the surface, the section, and the construction; second, by the various methods of percussion, from the light tap with the back of a knife to the forceful blow with a hammer, when the sound emitted, the resistance offered, and the rebound are noted and the transmission of force is observed by palpation; third, by the resistance to cutting; fourth, by bending; fifth, by breaking; sixth, by scraping.

In order to **inspect** the bone the overlying tissues are reflected carefully, then any changes in the normal pallor can be observed. Any marked redness requires special study and its extent and degree accounted for. The periosteum, having been inspected, may be removed; during this proceeding its texture, tensile strength, thickness, and adhesion to the bone is considered. The surface of the bone thus laid bare should be more or less pale and smooth. In degenerate bone it may be highly colored and rough in several ways, either granular, spicular, or massively rough. Considerable irregularities are generally due to localized pathologic changes.

Swellings of the ends of long bones are found in many diseases where serious chemical conditions exist, and are often spoken of as arthropathies, which they frequently are not. Such conditions may be associated with true joint disorders or may occur independently, or may be the cause of such disorders, and are often associated with nervous lesions, which probably in not a few cases depend on the same nutritional or chemical causes. Changes in contour are common in health and disease and are generally significant.

Percussion may be practised during life, to a limited extent, with profit by using well-rounded plexors and carefully graduated blows. Specially should this be done by those who routinely percuss the chest

in order to know how much of the sounds they elicit are due to the bones.

In percussing, we determine by the sort of resistance offered to the instrument, and by its rebound as well as by the peculiarity of the blow which is transmitted to the hand placed at a distant part. It will be seen that when the same sort of bone exists throughout a skull this transmitted tap or blow causes different effects, so that we must separate these qualities from those resulting from the architecture of the part.

In percussion of the skull one should first observe the position of the teeth, as curious errors have resulted by neglecting this. Percussion of the skull through the scalp is difficult, as the sounds are altered markedly, but in exploratory operations this percussion is most valuable, as the sound emitted by a skull with a considerable fracture is almost always characteristic. Small fractures do not always give clear results; for this work the end of the handle of a large knife or small chisel forms a convenient plexor. The sound emitted varies with the structure as well as condition of the bone, and yields such valuable results in some cases that it is well worth forming the habit of tapping all bones that are observed, so as to become familiar with the bone sounds which correspond with the different conditions. Bone resonance varies with bone structure and condition.

Resistance to cutting is noted as we saw through any bone, specially the skull, and in opening the chest we observe the ossification of the cartilages of the ribs. In young bones the stout knife often takes the place of the saw. In diseased or degenerate bones the point of the knife can be pressed into the bone, often quite readily. In sawing it is not always easy to be sure from the first cut whether the decrease of resistance is due to structure or substance, some apparently hard bone being easily cut, though quite thick; while some thin, translucent bone may be very hard. It requires some little attention and practice to acquire skill in interpreting the information we get from sawing through a bone, and this is interfered with if we use different saws, and if others have used the saw between two examinations, or it may have become jammed so as to cut differently, though but little dulled. Some bones tend to choke a saw more readily than others; such bones are usually less brittle, but not always more resistant to violence. The differences in the smaller long bones, such as ribs, are often very striking and interesting.

Bending is used to bring out the elasticity and resiliency. Owing to the unfortunate lack of proper words to express these two types of return to position after force has been applied, we are forced to separate two terms generally regarded as synonomous, though actually different. The ivory billiard-ball is the best example of elasticity, and the watch-spring, of resiliency. Equal and similar masses of these substances always differ. In the same way two types of bone differ.

The term "flexibility" conveys in part the same conception as resiliency, but cannot be applied to masses having any considerable thickness. In order to estimate practically these qualities we bend or twist the small

bones, either by the fingers or by means of the sequestrum forceps, and in the skull by testing sections or fragments in the same way.

In **fracturing** bones or bits of bone we note the way the part breaks and the resulting surfaces, as well as the force needed. In degenerate ribs, such as are often found in old women, it requires so little pressure to break the thin shell of hard substance that postmortem fractures are not uncommon. In other ribs, which show but slight difference to the eye, vastly greater force is required. When such soft or fragile bones are broken the substance within the shell may be squeezed out as a pinkish semifluid mass. In breaking the sternum, as directed under the section on Opening the Body, one gains an insight into the condition of the bones. This constitutes one of the reasons for advocating the method. Whenever there is serious change in the bones this sternal fracture will give us the information of its existence, as well as a fair measure of its degree. At times we are confronted with serious difficulties, and cannot fully test out the bones because we have not easy access to a physical laboratory; we must improvise one, and in these cases a hammer and a brick or other hard object can be used. A small bit of the bone is cracked like a nut between these two primitive instruments. From this simple method surprisingly valuable insight is gained regarding bone quality.

The softer bones and the softer parts of the long bones can often be studied by **scraping.** This is varied, from gentle to heavy and from slicing to crushing, by changing the angle of the knife-blade and the pressure exerted.

In this method the structure of the harder parts is seen and its resistance determined. The effective resistance to the process will be the resultant of the amount and quality of the bony substance and of its distribution. The substances filling this bony network will be squeezed out, and the resulting pulp will vary in color, consistency, and translucency, depending on the condition, and each variation gives an interpretable indication of these variations of condition. Such scrapings can be profitably studied under the microscope. Scraping of hard bone will cause a perceptible noise which generally gives very definite information regarding its quality; the sensation imparted to the hand holding the knife is quite as striking as the sound emitted.

Injuries.—Bruises may often be detected, but this is generally possible only when the overlying soft tissues are injured, though they may appear without contusion of the soft parts. Care must be exercised to distinguish between subcutaneous laceration and bruises of the bone; thus the tissues about the spine or hyoid bone or pelvis can easily be seriously injured and suffer severe laceration with little or no mark on the skin. Bone bruises may set up inflammation of the periosteum, which may later be associated with ostitis.

Overbending without true fracture receives too little attention. This is probably quite common in cases where the brain is injured without fracture of the skull, and is often associated with hemorrhage. I have seen some striking examples of overbent ribs, where the resiliency

of the outer shell resisted actual fracture, but the interior was seriously injured by squeezing. I have also seen overbending of the spine produce unnatural flexibility of the bony prominences without fracture or rupture of the ligaments.

Fractures cannot be understood, even vaguely, without a full realization of what bone is; not simply from the anatomy, histology, and chemistry, but as a structure composed of various building materials, put together on an architectural plan. The resulting bone, depending for its qualities on all of these factors.

No study of a fracture at a postmortem can be complete which fails to include the nature of the bone as well as of the lesion produced. Nor can one understand the lesion as found without a good grasp of the principles of mechanics. This I hesitate to state because of the tendency to reduce physics to a mathematic science. At the postmortem we need but little of the mathematic sort of physics, but we do need a great deal of comprehension of the principles that govern the action of force and the qualities of matter, and the way force and matter act together, for in no other possible way can we arrive at a reasonable conclusion as to what has happened, or how it came to happen as it did, or what forces caused it in cases of mechanical injury to the body.

The mere description of the lesions as found constitutes but a part of the problems which present themselves in investigating fractures. As those problems of causation are generally not of much interest except in medicolegal work, the discussion of the production of fractures will be found in the section on Wounds. There are many cases where injury has been done to important organs by *violence transmitted* through bones, with or without fracture, and to properly understand these cases one must realize how violence is conveyed through the various bony structures, and how it is dissipated or lost, and how it is delivered to other tissues, more or less modified by its transmission. This is generally a complicated affair in head injuries.

It should be remembered that it is seldom the fracture which causes the damage, but rather the force which is passed on by the bone. Other very serious complications of fractures arise from secondary woundings by fragments of the bone. In these cases it is necessary to determine the damage done by the primary violence, and that done by subsequent motion of the fragments and by sequelæ.

The **sequelæ** most commonly met with are laceration and hemorrhage. At times, where the condition is of long standing, efforts at repair, which are more or less successful, materially change the picture and may give rise to serious secondary phenomena. Following the laceration and hemorrhage one may find swelling, inflammation, or infection which may modify the fracture itself. Rarely one finds evidence of embolism from a fracture, the diagnosis is often made on insufficient grounds, and the diagnosis of cerebral embolism or coronary embolism simply means that there is gross ignorance or forgetfulness of the path the blood takes. Too often the element of shock is underestimated, and the recourse to embolism as an explanation is more than unfor-

tunate. To have such an embolism either a vein must be opened freely or a clot in a vein must be dislodged. The question of changes due to injury to bones has often been raised for commercial purposes, and unless the history and findings agree and furnish clear evidence it is not proper to draw positive conclusions.

Cartilages are at times involved with the bones, with which they are connected, or where they are not connected with bones, as in the larynx and trachea, they may be independently affected. It is usual to find the costal cartilages becoming hardened after middle life. The extent of this process depends on general bodily conditions more than on local ones, though there are exceptional cases when the usual concomitant changes are not found, and the condition must then be regarded as chiefly local. In persons who use their chest muscles normally in respiration this change appears to be retarded by the regular bending the cartilages receive. When found at or before middle life it indicates presenile changes. The cartilages associated with joints often share the disturbances involving these structures. At times disease begins in the cartilage and may extend to the bone or the joints adjacent. At times they may be separated or dislocated. Such complications rarely produce serious injury to the health and may easily be overlooked; though they usually produce a deformity which should attract attention, this is not always the case.

Joints may share with the adjacent bones and cartilages in injuries or diseases or may be independently affected. Swellings, fixations, and various inflammations are far from rare. They are to be studied when present, first, by inspection and palpation, then by dissection, always paying particular attention to the involvement of surrounding tissues. True arthropathies are at times dependent on lesions of the nervous system or are produced by some systemic infection, or through often repeated injuries by reason of occupation, faulty action or by joint weakness, or from overuse. At times the cause is chemical or nutritional, as in gout. Fixation of the joints in parts that are not used, either from paralysis or any other cause of disuse, may resemble those that have been inflamed. Affections of the knee are common, and infection of this joint is often, if not always, a serious affair. I have not rarely found such infections overlooked by clinicians. Death may result from such infections even where the surrounding tissues do not appear to be seriously invaded. Wherever possible, compare with other similar joints in order to judge whether the condition is purely local or partly or wholly general.

Ligaments vary much in different parts of the body because of local strain, irritation, or injury, but, in general, there is a striking harmony between these fibrous structures, and this fibrous type usually extends to the internal organs; is, in fact, part of the whole fibrous system of the body, and, as we have already pointed out, this is influenced by the resultant chemical conditions in the body.

In examining ligaments many different methods may be used, the selection depending on the location, function, and condition of the

structure to be studied. Generally it is well to clear away from the surface of the ligament the overlying tissue, then to gently test the quality of resistance by pressure or movements of the parts held together, noting the way the fibers are felted together, the way they play on motion, and the manner of insertion or attachment. In cutting, one may begin at one insertion and free the edge there so as to have the ligament intact, or after testing by motion, as above, and palpation one may cut through the middle of the ligament, using the notching method, so as to be able to replace the cut edges later. Evidence of too much effort at repair is quite as important as an indication of abnormality as is too little.

Special **examination** of bones and joints can be best carried out by making curved flaps over the parts, having regard to the difficulties of gaining view, of retracting the overlying tissues, and of subsequent repair of the region.

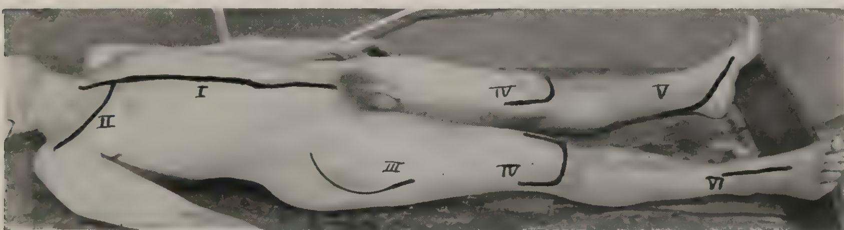


Fig. 250.—Lines Usually Employed for Opening the Joints.

I. The primary cut for opening the body. *II.* The secondary cut, which exposes the clavicle, shoulder, and axilla; by continuing it slightly the humerus can be disarticulated. This cut is made well below the clavicle. *III.* The curved cut to expose the hip-joint. *IV.* Line for flap to explore the knee. *V.* This cut allows one to thoroughly explore the ankle-joints; it is made just above the edge of the thick skin of the sole of the foot. *VI.* This cut is occasionally necessary to explore the front of the ankle more directly and the interosseous space. It is carried upward in fractures of the bones of the leg above the ankle.

Figure 250 gives a number of useful cuts for such examination, and represents those to be preferred unless some special condition exists.

Where actual bone disease exists it may be necessary to remove portions or even the whole bone. Such removal is apt to cause disfigurement; this can often be overcome by using a substitute made of wood.

In examining fractures the saw is always to be used when possible rather than the chisel. The skilful use of the chisel is often desirable, and for this work the selection of instruments suitable for the work is very important. The manner of using them includes the selection of place to cut so as not to destroy the conditions, and the direction of the application of force and the grading of that force are matters that can be only learned by practice. In general, it is best to cut away from the part to be studied, and to use too little rather than too much force, and repeated blows are best until skill is attained.

SPINE

The spine offers a number of special problems. When the organs have been removed in one or more masses the front of the spine can be examined directly, and by various motions of the parts the condition of the vertebræ and intervertebral disks, with the ligaments, can be tested. The main muscles and muscular attachments, with the processes to which such attachments are made, are to be studied as in opening the neural or spinal canal.

General conditions can often be made out by the examination of the spinous processes without cutting, but one is constantly liable to make mistakes owing to the conditions of rigor in the muscles. I have been called on to confirm a diagnosis of broken neck where all that existed was a limber one owing to the destruction of rigor mortis by the rather free manipulation of previous examiners.

On the other hand, I have found a seriously injured neck, where there had been actual dislocation with replacement followed by rigor, which produced an apparently normal condition. The wide range of motion in some spines differs greatly from the rigidity of others. These types must be recognized, and the determination of the type to which a particular spine belongs should be one of the first things done.

Normally, the neck allows of free motion. This can be investigated easily before rigor has set in by placing the thumbs along the spinous processes and the finger-tips along the anterior and lateral surface of the centra, being careful not to use too great force in pressing the finger-tips in, lest there be produced conditions which may be misleading, the finger-tips finding the groove between the air-passage and the lateral muscles. The hands being in position, an assistant moves the head from side to side and rotates it in all possible directions. This can be done without assistance by examining one side at a time, using the other hand to manipulate the head.

When the brain has been removed the upper end of the spinal canal can be examined from above, and much valuable information can be gained regarding the effect of motions of the neck by inserting a finger through the foramen magnum, and with the other hand causing various bendings and turnings. Perhaps in no other way can one so easily gain a realization of the extent and sort of massage given to the spinal cord by this mobility of the neck. I have had a number of persons try this, and they always expressed surprise at their findings. The mobility of the spine varies in each part and under many conditions, some of which are of the greatest importance. It is well, therefore, to devote some time to the study of the limits of normal variations and the factors which influence them.

The condition of the muscles, both as to development and use, has a distinct bearing on the suppleness of the spine, and, together with this, form a very potent factor in that stasis which is so often associated with neuritis of the spinal nerves.

In cases where spinal conditions can possibly form a factor the

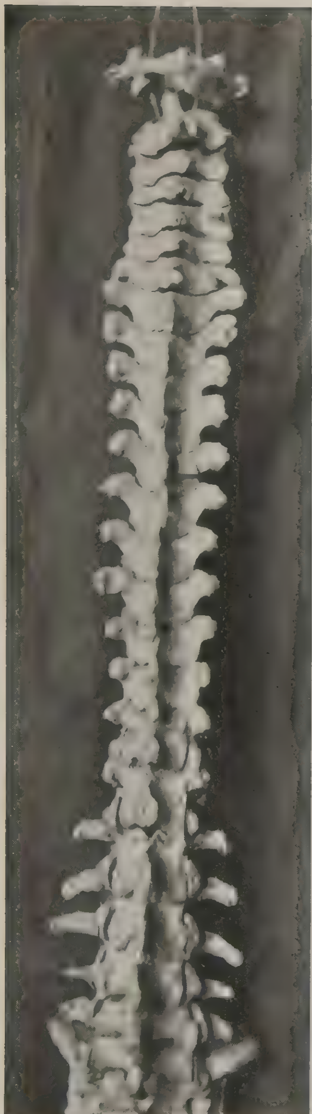


Fig. 251.—Spine from Back.

Slips of card have been placed between the articulating surfaces at the fourth cervical, fourth and tenth dorsal, and first lumbar vertebræ to show the planes of these surfaces. A knowledge of these planes make disarticulation much easier, as well as helping one to understand the mobility of the spine. The first cervical vertebra is separated to show the process of the "axis."

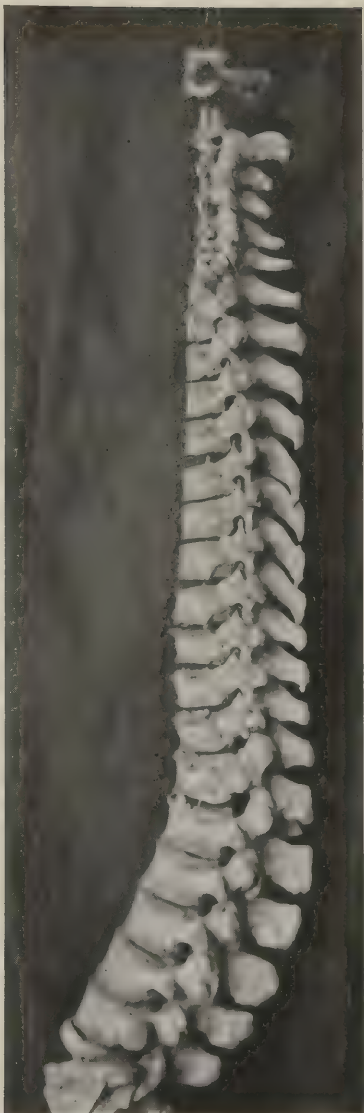


Fig. 252.—Spine from Side.

Compare with Fig. 251. Note the slope of the spinous processes as related to the facets. Also the abnormalities in the centra of the dorsal region. Few spines are free from some peculiarity that might be considered as abnormal, and when we compare many spines the differences are very striking.

examination of the spine by both hands, with the body on its side, one hand over the spinous processes, and the other over the centra, much

can be learned. The tendency of the body to change position can be utilized to produce various bendings and twistings, which cause changes that are noted by the two hands. Another valuable method of investigation is to support the spine and body at different points, and, after the body has been opened, to press strongly downward on the centra, noting the resistance offered and the spring back on removing the pressure. Another useful method is to lift the legs with one hand while the other rests on the spine.

Overbending may have been so severe as to injure the processes or even crush the centra. I have seen it produce permanent damage to the nerve roots, and well remember a case that had been examined by a number of surgeons where the great occipital nerve was affected by a sudden overbending of the neck, the head having been violently thrown backward. This having been overlooked, the person was regarded as a malingerer, though the lesion was easily demonstrated many months after the injury, and the history was quite clear. The effect produced in overbending will depend on the architecture of the vertebræ, on the ligaments, and on the intervertebral disks, and as these vary in groups or types and individually it is no simple matter to reach a clear and satisfactory conclusion. Injuries to the spine are so common that one cannot afford to be satisfied with the ordinary insufficient and erroneous conceptions, so generally prevalent, and while the problems are often purely mechanical and generally belong to physiology, they present themselves to us at the postmortem frequently enough to make it necessary to study them far more carefully than is advocated in the ordinary text-book.

When a local lesion is found it is at times necessary to remove a segment for further study. This may be accomplished by several different methods.

In the neck one may work from either the back or the front by dissecting away the soft parts and thrusting the point of the knife into the intervertebral disk, with the blade parallel to the surfaces of contact of the disk, and then cutting the disk by carrying the handle of the knife to either side, finishing the cut by removing the knife and replacing it in the cut with the edge pointing in the opposite direction. The small articular facets may be disarticulated or they may be cut off with saw or chisel. In the upper thorax I prefer to work from the back; in the lower thorax and lumbar region, from the front. By supporting the body near the point where the section is to be made the work is much facilitated. It is best to include one or more extra vertebræ in the segment removed than are involved in the lesion to be studied, because any artefacts produced by the manipulation are more apt to be in the ends of the segment. When special care is needed to avoid damaging a portion of the lesion, as when the bones are eroded or brittle from disease, it is better to cut the intervertebral disks and tissues in front, and then free the spine, as in removal of the cord, from the back. The articulations can then be more easily reached.

Where no injury is likely to occur I use a large carpenter's chisel

and a heavy wooden mallet for cutting disks and arches. It is well to remember that the articular facets in the upper part slope with the spinous processes, and in the lumbar region face nearly square to the side. The disarticulation of the ribs may be troublesome, and it is usually not necessary or desirable to take the time or energy for this proceeding; generally they can better be chiseled close to their articulation. In order to restore the body it is at times desirable to insert a piece of wood where the segment was. This should be a little longer than the removed segment and have pointed ends which fit into the spinal canal, the ends not being too sharp.

MUSCLES

While the muscles offer many problems of interest in themselves, both for the physiologist and the pathologist, which are not to be ignored at the postmortem, there are certain general matters of relationship which are of special value. The muscles are so entirely dependent on the chemical condition of the blood on one side, and on the activity of the nerves on the other side, that they become most valuable indices of variations in either. Any serious chemical change in the blood is apt to produce its effect on the muscles, but certain special changes are specially potent.

The blood is the only direct means the muscles have of communication with lungs and kidneys and the other eliminating structures, and equally true is this in regard to those organs which supply muscle food; therefore in the ordinary life any variation of either supply or demand must be met by this fluid. While this is largely true of all the internal tissues, it is particularly important where the sudden changes of activity in the muscles make the results more strikingly apparent in a very limited time. This is specially true of the heart muscle.

Aside from the ordinary normal demand for food and elimination, the blood not infrequently contains substances which directly and often powerfully affect the muscle substance. But the blood itself is entirely dependent for all these properties on other parts of the body; each of which may indirectly affect the muscle by variations in activity. Anything which affects the circulation in general or locally must quickly affect the acting muscle, and more slowly, but just as surely, the resting muscle. The muscle demands general tissue food to maintain its substance even while passive, and the tissue destruction during activity is greatly increased; beyond this a special muscle fuel is required in proportion to work done.

It cannot but be clear that changes of liver functioning will be associated with muscle changes just as soon as such changes affect the quality of the muscle foods sent out; so the organs that clear the blood of fatigue stuffs from the muscles are intimately associated with muscle health. There are, however, a large group of chemical substances from other organs and from disease, from infections, and from other poisons equally important.

It is of the utmost importance, therefore, that we realize how the muscular system as a whole is related to each organ in the body both in health and disease, and to understand the different degrees of sensitiveness of the types of muscle found in the body to each separate influence. We must recognize differences of kind and of degree in muscles, from the non-striped to the coarsest skeletal type, and in this series we find a very large number of subtypes too seldom considered in this way.

The vast importance of the chemical influence on the heart muscle is in a measure appreciated, but that it is not fully grasped is seen by the unsatisfying discussions of myocarditis.

If our histologic methods were but extended so as to give us a real microchemistry instead of only a few color reactions, we could rely more safely on the histologic method in studying muscle problems. Unfortunately, the stains used give us but a very fragmentary notion of the actual condition of the muscle substance. Beyond the size, shape, position, and the degree of staining of the granules and nuclei, the grave degenerations, and some little insight into how the muscle elements may be made to separate, we gain little from modern histology. It is necessary for us to know the condition of the muscle in a far larger way. This must include the mass development, the texture, the sort of rigor, the consistency, the harmony of total musculature, the special local variations, the muscle habits and their results on chemical supply and demand and the effect on the muscles themselves, and the mechanical indices.

When we consider the studies made in the minor laboratories and in the great laboratory of nature in regard to the action of chemicals on the different types of muscles—for example, atropin, strychnin, digitalis, ergot—we see that there is a greater difference in the chemical peculiarities of muscles than the microscope would indicate, and as we extend our knowledge of pharmacology and toxicology these muscle types become more and more significant.

When we attempt to study the heart muscle in infections where toxic substances are known to be present, and compare these effects with the effects of internal secretions, there is an element of despair in our minds at the complexity; but this should be controlled, and we should proceed in an orderly way to study and group our findings, so that we come to a realization of the meaning of phenomena that occur more or less regularly under given conditions, and are found in varying degree in the different types of muscle, each after its own type.

It is easy to recognize the effects of strychnin and the paralysis due to bacterial poisons. It should be only less easy to grasp the effects of certain poisons from kidney or liver diseases. When we see the intestines swell up and their muscles fail, we know the heart muscle is suffering and is in grave danger. We also know that the skeletal muscles share in this general effect.

After we have cut a number of bodies where death followed such a series of events we learn to judge of the intensity of the poison by a comparison of the condition of the various muscles, and then, if we find a relaxed gut with a contracted heart and soft skeletal muscles, we fracture the heart muscle to see how much it has suffered before it gave up under the whip, usually strychnin, that caused it to contract at death. We have an almost positive knowledge that such a drug complicated the picture after we find the muscle of the heart is easily torn.

The muscles serve as an index of the degree of effect as well as of the kind of poison that has circulated in the blood, and are, therefore, of the

greatest value to us in our efforts to understand just what has been going on in the body before us.

The response is so quick in some muscles, and so much delayed in others of coarser type, that we gain a new index of time or duration.

The color of the muscles is often significant, specially in such poisons as carbonic oxid and arsenic. In the heart muscle one can often note a similarity of color to that of the liver.

Fibrous invasion of the muscles is often general, and not rarely does one find it proportionally developed in the different types. Fragility of the muscles varies enormously, but the conclusions as to cause are entirely different where the whole muscular system shares it equally, as in old chronic alcoholism, from the case where only the heart muscle is fragile, as is often seen following severe hemorrhage. The fragility, or readiness in tearing, varies in kind as well as degree, for where there is fibrosis the resistance is increased, but the manner of tearing instantly shows the different type of tissue, and we have no difficulty in determining that the muscle itself is soft, though the fibrous threads are firm, any more than we have when producing fracture of a spleen that has an increase of fibrous skeleton, though, of course, the effect is not so striking.

Aside from the color which depends on the quantity and quality of the blood present, and the presence of fibrosis, we find changes of color and texture due to the presence of fat and of edema, and occasionally of degeneration, atrophy, infection, or actual tumor formation, but throughout all our considerations we must carry a clear conception of the different types of muscles.

These types vary with the sort of work the muscle has been doing, as any meat eater should know. If the muscle has been gently acting, we do not find the coarse fiber that characterizes the glutei. A skilful butcher can tell cow meat from bull meat at a glance, and we should be quite as skilful in our art in differentiating rugged from soft types, even if we do not attain the true skill of a myologist.

With the type and texture we must consider rigor, which has already been discussed; and that vast and interesting field of study, muscle development under the influence of the nervous system, must not be forgotten. It should be remembered that no nerve impulse can cause muscle to develop unless the chemicals are adjusted; also that no muscle grows without some exciting factor.

The muscles, then, are to be considered collectively just as truly as are the blood-vessels. This general study of the musculature of the body begins the moment we first see the body, and our final conclusion regarding it is one of the last things we can finish.

The great groups of muscles must be considered with a degree of individualization of the group. The first group to attract our attention will be the extremely delicate muscles of facial expression; with these are joined the throat group, which govern speech. The next group will be the head-moving muscles of the neck, whose development tells us so much of the nutrition and health of the whole body. Then the respira-

tory muscles which have their interior partners, seen only after dissection, and with these the diaphragm and abdominal or lower accessory group of respiration. The great motor muscles of the back also require the opening of the body to allow full grasp of the spinal mechanism. Then the massive leg movers, which tell us of the development and use of these supports, not of the position only, but of the health of the body.

So clear is it to those who understand health that muscular activity is one of the main supports of health that I am astonished and ashamed when I find persons ignoring the whole subject, while pretending to measure the forces that have produced disease in a case at the postmortem. One hesitates to use the proper word which would suitably characterize the clinician who would ignore muscular exercise as a part of his efforts to restore health and combat diseases. Yet at the postmortem we are but carrying out to a finer and more complete degree the study of the case that the clinician began to observe.

Those who ignore their muscles degenerate, and the pathologist who ignores the muscles at the postmortem certainly does not benefit by so doing.

The specialized muscular tissues in the viscera all respond to the chemical atmosphere of the blood, which is powerfully influenced by the activity of the large motor and skeletal muscles. The heart is peculiarly responsive to this influence, and one of the reasons why we have so many unexpected deaths from heart failure is because we do not have a clear realization of this relation of the various muscles, and are too prone to adopt the half philosophy of rest cures in an unthinking and empirical way, and the errors of the muscle trainers are just as serious in their effects.

The muscles as we see them in the dead body show by their shape, size, development, and consistency much of what has been going on not simply from the chemical side, but from the nervous side. This matter of nerve tone and resultant motor impression is too seldom considered except in cases where grave trophic lesions are found. The variations that are superimposed on the general condition, if studied alone without comprehension of the groundwork, lead but to fanciful errors comparable to those of the epicycles of the ancient astronomers or the details of malarial manifestation without a grasp of infection.

Muscle changes are local and general. Taken as a type, the heart shows how the muscles are influenced by defects in other structures. A faulty valve produces secondary changes in the muscles of the chambers of the heart. So also obstruction in any hollow organ or tube brings about muscular changes above the obstruction, and in the air-passages this is strikingly clear.

The first group of changes that begins as physiologic response to work is hypertrophy. At first this is local, and is to be always judged by the relative development of the affected area as compared with unaffected parts of the muscular system. The next group of changes is that of atrophy; the common causes are chemical, vascular, and nervous, and the rather rare condition of primary myositis.

True exhaustion is not often noted except in the heart muscle.

The absence of food through vascular defect, or the failure of the muscle to use what is presented, or the chemical unfitness of what is presented, are all possible elements in the problem which are at times quite as important as the factor of labor demanded.

The effect of nervous excitement should never be forgotten in relation to muscle exhaustion.

The actual work done can usually only be estimated indirectly.

The condition produced shows in structural and in textural changes.

A common cause which acts generally in more than one of these modes is infection. The great group of degenerations which belong strictly to pathology are occasionally met with, and when suspected or found are to be studied according to the rules of that science. Injuries to the muscles and their sequelæ require careful dissection and thought. In medicolegal work their investigation is often of the greatest importance.

PART IV

SPECIAL CONDITIONS AND LESIONS

WHILE the text-books on medicine, surgery, and pathology tell us much about lesions, there is a point of view which attaches to high-grade postmortem work which requires consideration.

It is only possible in our limited space to give a few very brief suggestions, more as reminders than as a discussion of the subjects.

I have arranged what may, with more or less accuracy, be called the major groups of lesions alphabetically for easier reference, reserving a few more general conditions for separate consideration. These paragraphs are intended to bring to the mind of the operator certain fundamental matters that are important, and it is hoped that they will be less unreadable than the more usual form of lists of "things to be observed."

They embody the things which my experience has led me to consider the essentials, and which are not always recalled, if well known, by the busy operator.

Absence of Parts.—This condition results from congenital conditions, disease, or ablation, and its significance in a given case depends on the function of the part, and whether its function can be assumed by some other part. When one of a pair of organs is absent, the other is usually found enlarged. Where an organ has been destroyed by disease or removed by operation, it is common to find some degree of compensation in other organs. This must be remembered in judging of the condition of such other parts or organs as can share in this compensation. On the other hand, there is apt to be atrophy of dependent tissues or in those which normally would be associated in action with the missing part.

Adenitis.—All glandular bodies are more or less subject to various peculiar local changes. The types vary somewhat with the function of the gland; specially is this true of glands with specific secretions. It is necessary to recall the normal and pathologic relations of the gland before judging of the significance in a given case; it is never enough to simply regard the adenitis as an isolated finding. In lymph-glands the distribution of associated lymph-vessels and the conditions in the territory they drain are of prime importance. Pigmentation is always significant. The tension and congestion of glands are to be noted specially. Cysts are common, occurring usually in the ducts when present, and in ductless glands in the substance, and usually contain some of the characteristic secretion, more or less modified, this depending on the nature and severity of the process.

Infections should be traced to determine the mode of entrance. They may be suspected in all glandular involvement, but we must not forget the part played by autogenous chemicals.

Adhesions frequently follow irritation, often follow inflammation, and in certain places generally mean that there has been a local infection.

One must not mistake anomalies of ligamentous type for adhesions. This has been done in my presence by those who should have known better. Rash conclusions regarding the cause, effect, and general meaning of adhesions are far too common and should be avoided. While the mechanical effects are generally the most essential part to study, we must consider the chemical conditions which permitted, encouraged, or modified their production, and which give rise to variations where the exciting cause is the same.

Anemias.—General anemias constitute more or less well-recognized diseases, or are associated with conditions of certain organs, or they may be due to some accident of nutrition or follow a hemorrhage. Local anemias are generally to be carefully studied, so as to determine why they exist and what effect they must naturally have. Occasionally they are produced after death by pressure on the part or by hypostatic drainage. In life it is possible to have the result from these causes, but generally they follow some disturbance of the local circulation, as from occlusion or constriction of the vessels. Organs or parts profoundly at rest show a relative anemia often in marked contrast to the congestion of strong action. Continued disuse of a part from paralysis or any other reason accentuates this form of anemia.

Anomalies.—This term is often applied rather broadly to include defect, malformation, and displacement. When the condition is not serious, life continues, and various compensations may be established even where the sort or degree is detrimental. While usually congenital, certain forms probably develop after birth.

Asphyxia is a composite lesion, and as such varies with the cause and degree. Not a little confusion exists in the literature of this subject as a result of the authors having but narrow pedantic viewpoints. The problem is distinctly a physiologic one, no matter how clearly marked may be the pathologic factors.

Asphyxia will arise whenever the supply of oxygen is cut off, though typical asphyxia has an element of carbon dioxid poisoning. The type of findings where oxygen starvation is produced by inhaling freely some gas like nitrogen will be different from that produced by inhaling pure carbon dioxid, and a still different type will appear in the inhalation of more poisonous gases, such as carbonic oxid (monoxid), the difference being due to the poisonous effects of such gases, that of CO_2 being at first stimulating to certain nerve-centers, then numbing, while CO is actively poisonous at all times.

Nor should we forget the chronic poisoning by CO_2 to be found in chronic defect of the respiratory or circulatory apparatus, which presents very different pictures from those found in suddenly produced asphyxias.

The air hunger following loss of blood is a sign of internal asphyxia which constitutes an entirely separate type—the anemic. The air hunger produced by high altitudes is still another type.

Most of the cases seen at the postmortem are due to some mechanical disturbance of the respiratory or circulatory apparatus, but it is strange how seldom we find an adequate realization of the causes of such mechanical conditions.

Many other poisons besides CO_2 affect the respiratory center, both directly and reflexly; anesthetists are painfully aware of this. Respiratory arrest may arise from direct poisoning, by powerful reflex stimulation, or by simple exhaustion of the center, as is evidently the case in infants.

The stoppage of the air current by mechanical means may be at the external openings or anywhere along the air-passages, and may be due to smothering, foreign bodies in some part of the canals, secretions, spasms, swellings, edemas, hemorrhages, growths, or inflammatory processes.

The failure of the air to pass to the blood may depend on the condition of the lung tissue or the blood; the failure of the blood to carry on internal respiration may depend on blood changes or some disturbance of the circulatory apparatus. These main types of causation may be variously combined, so that the appearances which are more or less characteristic of each may be masked or blended. The effects are to be noted, first, in the color and condition of the blood itself; next, in its distribution. The color of the blood in the simple asphyxias is dark, but on exposure to air rapidly assumes a bright red, which helps to distinguish two of the great types—chemical and mechanical.

When the red cells have been poisoned or affected by electricity or any other hemocytolytic factor, the formation of oxyhemoglobin is retarded. The active mechanical asphyxias usually show great reflex determination of blood to the thorax, often with irradiated vasomotor relaxation and a tendency to minute hemorrhages, which are not distributed along the normal isohemodynes (lines of equal blood-pressure), but are grouped in such a way as to prove positively that local changes in blood-pressure have been added to those general changes which are more generally accredited to asphyxia.

The mere finding of asphyxia is but the beginning of the study which should lead us to a careful search for the cause, and for the other associated effects produced by that cause.

In asphyxias we find that the rapidity of the CO_2 poisoning is often shown by a difference in the indication of violent internal or sthenic reaction. In hibernation and Yogi sleep this is reduced to the minimum, while in drowning or other sudden forms it is usually extreme, though it may be lessened by other factors. The various asphyxias found in anesthesia are extremely interesting and instructive, and I find it profitable to study them while attending surgical clinics. Here we see all grades, from the most violently sthenic to the quiet fading away resulting from failure of the respiratory centers. The distribution of the

blood after death is an extremely important factor in all studies of asphyxia at the postmortem.

Atheroma.—There is an objection to the use of this term except in relation to a certain type of degeneration, but as we have so many nice new terms for the types of degeneration, and no other adequate one for the patches found in the blood-vessels, we are justified in modifying its original meaning to suit our needs. These patches are generally scars which mark the site of former processes of change, and these patches vary greatly, depending on their age, extent, position, and the general condition of the vessel walls, also on the process that they follow. Some are true sclerosis, some have necrotic masses, some are soft and elastic, and until a suitable new name is found we may use the one that was given to the patches partly through error in regard to their nature.

To refuse to use names originally given in error would upset a large part of medical nomenclature. Whenever atheromatous patches are found it must be made clear by actually testing their consistency and elasticity as well as the condition of the rest of the vessels in the immediate neighborhood what effect such patches have on the blood-stream at that point.

Circular patches with little elasticity are always serious, but how serious depends on the part or organ supplied by the vessel they occlude, and how much occlusion there is to normal or active blood flow.

Atresia is mostly used in relation to congenital conditions, as such it may be a defect or an anomaly. It seems desirable to consider its usefulness to express extreme simple closing of a channel by some acquired condition. Thus, atresia of the gall-bladder cannot be adequately described by any other known term. Such simple closings are found in arteries, in parts long disused, either following injury or as in the fetal circulation. When met with, these conditions are interesting, but often difficult to explain because the active cause has usually disappeared.

Atrophy may be apparent, as in intense anemia, dehydration, exhaustion, or starvation, but this type is readily recovered from under favorable conditions.

Real atrophy is brought about by loss of cellular substance or elements or removal of intercellular substance by any of the many pathologic conditions leading to tissue wasting. The apparent form can readily pass into real atrophy; this may happen quickly following vascular obstruction, or slowly in senility.

Atrophy of disuse affects the whole part, but not equally, the specialized tissues giving way first. Atrophy of overwork or exhaustion shows effects on the tissues engaged in the work. Atrophy by vascular change follows the distribution of the vessels, which show such change on dissection, and the appearance of the indifferent tissues is apt to be characteristic.

Atrophy by fibrosis shows increased resistance to cutting and to tearing and evidence of constriction of the other tissue units, and is seen in two main types—massive compression and interstitial change.

Atrophy by degeneration is apt to follow special toxic conditions or local inflammatory processes with or without infection.

Inflammation may produce mixed types where vessels, fibrous skeleton, and parenchyma are affected in various degrees.

All atrophies demand the closest attention, and in order to avoid serious errors all the possible causes must be considered in each case, and the anatomic, physiologic, and pathologic relations will require careful and skilful analysis, and no final conclusion should be drawn until the question of the possible nervous influence has been well thought out. In the skin and muscles this factor is well recognized; in the bones not so well. Of this action in the viscera very little if any true appreciation is to be found.

Blebs are often seen in the skin as the result of physical and chemical irritation and sometimes as sequelæ of infection. They may contain watery, albuminous, or bloody fluid. Blood blebs in the living are generally the result of serious infections, such as give rise to purpura. After death blebs form during putrefaction. The same process gives rise to edema in the deeper tissues, and true blebs are rarely seen in the interior. When found in those recently dead, with few other signs of putrefaction, they point to severe general infection if they did not exist in life.

Blotches are more or less permanent areas of local color change, and may be due to intra- or extravascular variation of blood content, or to pigmentary modifications, or may indicate irritation, either chemical or physical, or infections. In the skin they are at times due to nervous disturbances, and may be found to follow the distribution of certain nerves. They may occur singly, scattered, or in groups, each type having its special significance. When grouped, they may give a mottled appearance. In solid organs they may be on the surface or may have considerable depth. We have no adequate term for such massive blotches.

Bruises are apt to show more clearly several days after death by reason of the drying of the surface and the spread of the staining process, due to decomposition of the blood in the tissues. Where the outer layer of skin has been injured the drying is increased, often forming a dry, hard mark. Postmortem bruises also dry out more rapidly than the surrounding tissue, and at times blood is found extravasated into the tissues, but the element of reaction which shows itself by edema and swelling does not appear. Late postmortem changes, however, often resemble antemortem bruises in spite of the dictum of certain writers.

The position, extent, degree, and shape of the lesion help us to determine the amount of force and, at times, the direction of application. Any tissue may be bruised, but the picture differs in each tissue, varying not only with the force and its peculiarities of application, but with the peculiarities of the tissue itself, and with the resistance offered by adjacent structures. The effect produced by any force depends on its quantity, and the speed with which it is transmitted to the tissues and the area over which it is applied. The way the tissues receive, resist,

transmit, or transmute this force depends on all the physical properties of structure and substance.

It is a mistake to regard a bruise as simply a small hemorrhage, because there are wide variations apart from the extravasation of blood. These produce reaction in the tissues which vary with the type of injury inflicted and markedly affect the healing.

A quick, sharp blow when the vessels are filled produces a different sort of bruise from a heavy crushing blow which does not tend to burst the vessels. While the bruise from a direct squeeze is apt to show more reaction than hemorrhage.

Glancing blows give still more marked differences by reason of multiple lateral disruptions and greater superficial changes.

The age of a bruise can be surmised, but not actually determined, because different tissues and different individuals show such marked variability.

One should not forget that blood escapes if there is a cut in the bruise, so that it appears less severe, and that the amount of blood often tends to mislead. Old bruises show decomposition of the contained blood, with color changes from red to purple, followed by various greenish yellows to browns.

Repair varies with age, sex, and individual peculiarity. Bruises are frequently associated with other evidences of violence, which should be considered separately and in connection with the bruise both as to cause and effect.

Burns vary much, both in degree and type. Unfortunately, surgeons speak of degrees of burns, when a little thought would show that what they mean is depth.

The term "degree" should be restricted to the intensity of the burn. We find the effect produced on tissues varies with the quality or intensity of the heat applied, as well as with the time of application. Heat, being the lowest grade of radiant energy we study, differs entirely in its rate of penetration, as well as the effect produced from light and electric emanations, which penetrate, if at all, quickly. Heat does not in the ordinary intensities penetrate, but is transmitted through the tissues, and this takes time, so that the deeper parts of the burn differ from the surface and the intermediate regions. The chemical substances contained in the tissues are precipitated or coagulated, each having its critical point, so that the effect in any given part of the burn will depend on the tension or degree to which the heat attains at that point. It appears likely that even a partial coagulation often can be recovered from, but complete fixation never, so that we at times find a line of demarcation along which slough will separate. This is seen in high-tension burns, such as those produced by the arc caused by electric currents. Where actual coagulation has occurred in the blood-vessels there is greater damage.

Practically, this whole subject is of great importance, not only to the medicolegal expert and the surgeon, but should be to the intelligent pathologist, for infections grow in these coagulated media in burns in

peculiar and characteristic colonies without the hindrance found in ordinary tissues. The picture presented by sterile burns varies with the degree of heat, the amount taken up, and the time of application on one side, and on the various peculiarities of the tissues affected with regard to moisture, circulation, coagulability, and heat transmission rate on the other.

The age of the lesion and the reaction set up, with the secondary changes due to so-called treatments, infections, and systemic effects, all share in the complex lesion we are called on to describe, study, and, if possible, understand.

Sun burns resemble those produced by small quantities of extremely high-tension heat on one hand, and x-ray burns on the other, and cause reaction in the deeper layers of the skin unless the radiation was obstructed or converted by the presence of pigment. The large x-ray group of radiant emanation produces a great variety of effects, from surface redness to deep-seated tissue disorganization. The tissues of the surface tend to absorb and convert the lower tension rays, while the higher tension rays may pass through with little apparent effect.

The ordinary heat burns form several series of effects, from the low-tension hot-water-bottle type, where the effect is often quite deep, to the surface scalds of steam or boiling water, which are apt to be superficial owing to short time of application; and actual cautery.

The changes wrought in the blood are apt to be increased in deep burns, not so much by local changes as by the continuous flow of blood over and through the overheated part, causing physical and chemical, and, in extreme cases, cytologic changes. The amount of the body surface that can be burned is not a simple matter to be settled by glibly uttered rules, but by a careful study of all the effects produced in a given case, of which blood changes, tissue destruction leading to necrosis, shock, and infection are most prominent.

The interference with skin function is a minor matter, often grossly overestimated.

The blood destruction is a very important factor, and the elimination of the detritus is a serious business. The disturbances of the nervous reflex mechanisms connected with the skin are often severe and are not to be dismissed in the usual way. The outpouring of fluids in burned areas and the scar-tissues cause complications that are often important and require careful analysis. Chemical burns differ widely with the substance, its concentration, and the time it remains active.

Calcification occurs normally in bone, and this varies with age, increasing to a period well past middle life, after which it may even retrograde. Where it is found in abnormal places we should compare the findings in the part with the deposits found in those structures normally containing such deposits—that is, the bones and cartilage. Of secondary deposits in old scars following inflammatory processes, such as are often found in the aorta, the arteries, tumors, and tubercular areas, we find markedly different types; these should be considered as

indices of the processes and the reactive qualities of the tissues. Calculi by secretion, while different in shape and appearance, depend largely on the same general type of cellular activity, and indicate some unusual or abnormal influence acting on the involved cells. The problems of calcification are primarily biologic and only secondarily chemical.

Callus is simply a hyperplasia which usually results from intermittent pressure, generally with some side rub, consequently it is most often found in the skin, but it is not confined to this structure. It is common to regard such conditions when found inside the body as the result of an inflammatory process.

Caries is a term usually limited to destruction of the bony tissues, and generally depends on some chemical agent, frequently developed by bacterial activity. The extent, stage of advancement, sort of process, rate of extension, and involvement of structures form part of the basis for a description of as well as for the study of the cause and effect of and the understanding of the lesion. The predisposing and exciting causes being essential to the production of the lesion are important, but not always easy to determine.

Catarrhs arise when tissues are irritated so as to cause the cells to throw off either abnormal quantities of normal products or abnormal products. Generally we find such conditions are recognized as catarrhal only when they exist in the mucous membranes. Not having adequate terms for the same condition existing in other parts of the body, one is tempted to apply the term to this irritational extrusion from the cells. The process is so closely allied to the production of internal secretions and antibodies that it would be well if we had a broader philosophy of the whole question of chemical extrusions from irritated cell protoplasm. The substances thrown off form an index of the extent and degree of the exciting and predisposing causes.

Cicatrices vary from the barely perceptible line of a well-healed wound to the massive overgrowths of keloid formation. The degree of contraction found in scars varies enormously, but one often finds it difficult to account for this difference in any but a general way by pointing out that scars resulting from certain infections show an extreme degree of contraction, while other equally severe infections show extremely little. Thus, certain forms that inhabit the genito-urinary tract are prone to give rise to great contraction. Syphilis often shows firm scar-tissue, but seldom great contraction. The disfiguring scars following burns are probably at least in part due to secondary infections, while the keloid type depends on the individual or racial tendency.

The size, shape, contour, depth, and location often help us to judge of the primary lesion, and at times of the cause as well as course. Scars very commonly follow infections of the skin; in such cases the number of marks, their grouping and distribution, as well as character, often clearly determine the affection. The physical properties of scar-tissue must be tested carefully. The effects of scars should not be neglected, but their chief value is the evidence they give of past serious conditions. In this connection the age of the scar should be tentatively estimated.

Congestions include all blood-content increase, such as physiologic determination, injected vessels, engorged vessels, distended veins, swellings of tissue by blood in the blood-vessels, capillary dilatation, general hyperemia, and passive or hypostatic accumulation. Congestion generally is less marked after death, but this depends on the lowering of blood-pressure in the vessels and the subsequent contraction of the walls, and more or less on hypostatic settling of the blood. It is not always easy to determine exactly what the value of the different factors is in any condition, and the changes that have taken place since death set in still further complicate matters. In general, the changes in the arteries are greatest and in the veins least after death. In active physiologic determination the veins are apt to be moderately filled, while in passive congestion they are usually engorged. In inflammatory congestions the small vessels are very often markedly engorged, while the larger ones are not proportionately affected. The total amount of blood in the organ and the way it exudes on section, fracture, and compression will often help us to judge of the condition. The distribution of the blood by organs and tissues is one of the best of all helps in this study.

In case passive congestion is suspected, it becomes necessary to look for the cause. In all cases the appearance of the area should be carefully noted before handling the part. Then, by cautiously noting the effect of compression and section, one can judge of the openness of the blood paths by which the blood moves under the impulse of pressure.

Certain types of congestion point to serious vascular changes, such as occlusions and infarcts, in which case the distribution of the particular vessels will be more or less clearly marked out in the tissue. In inflammation the other effects, while tending to obscure the congestion, help us to arrive at a just and true estimate of the process of which the congestion is but a part. The color depends quite as much on the quality of the blood and the condition of the tissue as on the degree of congestion.

It should be remembered that congestion is a natural physiologic process by which repair of injury or infection is brought about as well as increased functioning supported, and that the line between physiologic and pathologic congestion is not to be drawn, and though the types are clear enough at times, they may exist together, as in an organ which is actively at work though inflamed.

Contractions and **contractures** are easily confused at times. The term "contraction" should be used for muscular findings where the process is recent, while "contracture" implies a condition of longer duration and more permanent effect.

The contraction which occurs in lesions of other tissues might better be described as either compaction, shrinking, or retraction. All contractures are significant and need careful study, the amount, of course, depending on the possible importance to the case. They are often due to nerve lesions which may be local, distant, or general, even though the contracture is limited to a single part. Asymmetry of pupils, face,

hands, feet, or other muscles, in the matter of degree of contraction is to be judged with caution, but never overlooked. The state of the muscles of a part after death may be, as already indicated, due to accidental posture, to habit, to local condition, to local irritation, such as violence or electricity, or to some central nerve condition. At times we find purely reflex contractions that result from causes which exist in distant parts; thus, severe pain in the belly will often cause marked facial and postural contractions that are more or less characteristic.

Contusion may be used when the word "bruise" is distasteful. The old definition, "a bruise caused by blows," is in keeping with the origin of the word. As no attempts to combine this word with various limiting words has ever proved satisfactory for the clear description of lesions found, it might be well if we abandoned the pedantic attempts of early days and returned to such useful common words as cut, bruise, crush, rip, burst, and tear more frequently, and avoided the clumsy attempts to make a few big words take the place of the many apt ones that we find ready at hand in the language.

Crusts and **scabs** are found on the surface after various lesions, either by violence or infection. Crusts should be restricted to dry desquamative processes, such as are found in certain skin diseases. Though scab is thought to be inelegant, it is a valuable word to indicate the dried exudate which forms a resistant coating over denuded areas. Whatever word we may choose, the description of the lesion should be made clear and its observation complete—the size, shape, elevation or depression, adhesion to base and at its edges, cohesion, thickness, color, texture, resistance, surface and translucency, with its effect on the base and what is actually under it of exudate, pus, granulation, or sore. The degree of dryness is often a matter of importance.

Cysts are most frequently found in or about tissue which normally gives out fluid secretions. They may be in the body of the gland or form by occlusion of the duct. The contents will often contain the specific chemical which is characteristic of the particular gland, but this may be greatly changed, as when inflammatory processes have existed. Many cysts are due to such inflammatory processes, some to desquamation, others to accidental compression, some to overgrowth of cells, some to fibrous contraction (or compaction).

When cysts have existed for some time the contents may become watery by absorption or by precipitation on the walls, or there may be concentration. Often there is decomposition of the desquamated epithelium. Sometimes blood, pus, or new substances that indicate pathologic secretion are found. It should be remembered that cells under excitation extrude substances by a process not unlike secretion. The glandular type of cells is more apt to do this, but the process is not limited to them. These extrusions when confined are termed cysts; when discharged, catarrhs or exudates. Extreme vacuolation of cells may give rise to cysts. Another type of cyst is found after necrotic change. Still another is that associated with certain parasites. In

all cases one should avoid prematurely rupturing them and conform the dissection to the case.

Cysts which occur in glands cause loss of effectiveness of that gland, more or less serious damage to the gland, and certain secondary mechanical and chemical results. The presence of cysts in the substance of the internal glands should cause us to carefully review the whole physiology of such organ, in order that we may judge whether our findings bear out or modify present theories.

In judging of the contents one is often puzzled to determine how much of what we find was originally there, how much is due to secondary change, and what it signifies. The consideration of the age, extent, evidence of inflammatory processes, and peculiarities of the containing organ will often throw light on the cyst itself.

Defects which are usually noted as gross anatomic anomalies generally begin at an early stage of the development of the body by one of two means: (1) Some accident which disturbs and modifies the growth of the tissue which would normally become the part found to be defective; (2) weakness in the force that impelled the development. The two can at times be separated by noting other evidences of deficient developmental impulse. One must distinguish the effects produced by other deficiencies from those actually resulting from a particular defect.

Deformities arise from defect, deficiency, disease, and actual disturbance or accident. At times it is difficult if not impossible to determine the part played by the participating factors. Those arising from congenital and developmental factors are often occult. Those caused by disease may occur through atrophy, destructive necrosis, or overgrowths, as in tumor. Those classed as accidental may arise by habit, occupation, or some form of violence. In each case one has to consider not only the extent of the lesion and its effects, but the other effects of that which caused the deformity. The history of the progress of the deformity may be written plainly in the tissues or may be wholly obscured, but should be searched for intelligently, and unwarrantable theorizing avoided. The great mass of deformities, however, are simply results of processes which leave clear evidence of their nature and degree. The effect observed will have been, of necessity, influenced by the resistance of the body, its power to react, and its tendency to sustain processes of repair; though overwhelming injury or disease and temporary conditions of body may have been such as to give the impression that the bodily powers were lower than they actually were.

Denudations result from attrition, solution, and necrotic processes, as well as from the devitalization consequent on trophic changes following nerve lesions or toxic conditions affecting locally the involved cells. Often one is confronted by lesions which result from a combination of conditions—thus, a burn in a paralyzed part, or an ulcer in a bruised area, or an electric burn where the nerve has also been electrolyzed by the current—in such cases it is eminently wrong to overlook or ignore any of the causal factors. The secondary changes which occur in complicated cases often quickly modify their appearance, so that it becomes

difficult to fix the value of the exciting cause even when one can obtain a good estimate of the predisposing factors.

Deposits consist of substances either normally present in limited amount or entirely abnormal products, or those which may be normal elsewhere, but not where found. They are found in the cells, between the cells, in the intracellular substances, or in spaces. Sometimes by filling the cells they destroy the protoplasm, and become what the mineralogist calls "pseudomorphic." Certain substances are absorbed by tissue in excess, either by overfeeding or overdigesting, or by a perverted action of the cells which show an unnatural avidity for the substance in question. Certain other substances are excretions and waste products, while others are foreign substances, like the metals which become fixed in the organic chemicals. Solid particles of foreign matter are also taken up. Irritations of various sorts often cause the protoplasm to take up or to excrete abnormal quantities of such substances, and after a longer or shorter period we find them deposited.

We have various names for deposits of the different materials and for the different forms they assume. Sometimes the term "infiltration" is used, though this is a most unwarrantable retention of the ignorance of bygone days. Deposits of lime salts, uric bodies, fat, albuminous compounds, dust, metallic particles, bile, pigments, fibrin, fluids, all demand a careful study of the forces which lead to deposition, predisposing and determining, and, of course, the effects.

Depressions arise as the result of compression, absorption, erosion, atrophy, retraction, contraction, or ablation. In examining the exterior such depressions are often misleading, specially about the head. Many diagnoses of injury result from such mistakes. Depressions on the surface of solid organs often result from simple bending of the part. This is seen in the liver. When in doubt, a transverse cut through the area will usually clear the matter. Secondary changes may arise from the cause that produced the depression or as a result of it. Pitting usually requires special investigation.

Desquamation is a normal process that varies much in different parts and in different conditions and individuals. In parts protected by bandages the product is retained and accumulates often to a marked extent. In the mucous membrane of the mouth after fasting there is a similar accumulation. In certain inflammatory processes the normal process is markedly interfered with, and in the exanthemata one often finds characteristic desquamation where other evidence is lost through postmortem changes. After death, particularly if the part is moist, one finds often an apparently abnormal collection of cellular débris, specially in the skin of the palms and soles, in the bladder, and in the mouth. Such findings are likely to mislead the uninformed.

Dilatation may be active or passive, that is, it may result from overdistention or from simple relaxation; it may be both active and passive. It affects all hollow structures that normally possess a tonic degree of contraction.

Simple distention, even when carried beyond the usual or normal

limits, may pass into dilatation, but lacks the element of permanence. A dilated organ may be also distended or contracted so that the degree of the lesion may be greatly misjudged.

Mechanical causes are apt to be the cause of distention, and if continued this becomes chronic distention, but we are disposed to regard true dilatation as combining with chronic distention an element of relaxation even in the active type. Ordinarily, relaxation soon follows prolonged distention, and it is often difficult to say how much, in any given case, was due to the mechanical and how much to the vital factors. In muscular organs, like the stomach and heart, we examine the tissues under the microscope, but in elastic organs, like the aorta, the microscope does not give us much help in our attempt to measure the change of resiliency; if, indeed, we do not overestimate the value of what we so gather regarding the quality of the muscle. When we find an organ empty but not contracted, we must be sure it was empty at death, or that it was not overdistended a sufficiently short time before to preclude tonic recovery. The condition of the various component layers and of the contained blood-vessels and the relations with other parts will often help us materially. When possible, we discover the mechanical cause, and reason out the vital condition after careful observation and tests of the involved tissues.

Diseases.—The word "disease" has been used in a number of places in this book, and in probably very few of those would there be any difficulty in comprehending the meaning.

It is not only proper, but necessary for us, however, to consider what we mean by a disease, and why we use the term in any given case. The term is used in so many different ways that it is quite impossible to accept any definition which defines or limits its meaning. At one time it is used to indicate a single symptom; at another, a group of symptoms, either connected as a symptom-complex or unconnected, save as they occur together. Still again, it is used to indicate a causal relation between manifestations (signs and symptoms) and some condition, as an infection. At one time it is restricted to a single organ, at another it includes all the tissues.

In bacteriologic studies there is a marked tendency to confuse the mere presence of the germ with the disease, so that the finding of the germ is considered as equivalent to a diagnosis of the disease. This tendency has given us much trouble and many misconceptions which have done much to becloud the philosophy of the subject and very seriously retarded right thinking. In mental disorders, on the other hand, the causes, unless they are claimed to be bacterial, have been very generally ignored. In physiologic diseases there is the greatest laxity in thinking, with the least display of fundamental principles. In anatomic diseases there is a very common disregard of the simple law that structure is the result of physiologic activities, either normal or abnormal.

It is clear that any conception of the term disease must include all proper uses of the word. The term must remain broad and inclusive,

and, therefore, it cannot be definite. Take any list of diseases and abstract from each separate example its contained thought, set these down in order on paper, and see what there is in common which makes us willing to call these conditions diseases.

First of all, there must be some manifestation, either a sign or a symptom or groups or types of these.

Second. All manifestations show abnormal action on the part of some bodily tissue.

Third. The disease is distinctly not the cause.

Fourth. The condition must have some degree of permanence.

Fifth. The manifestations differ in their relation to the disorder—in some they constitute all, in others the primary, in still others only the secondary, indication of the disease.

Sixth. No disease has been adequately or finally described until the quantitative and qualitative changes of all the tissues of the body are listed.

Seventh. The fundamental physiologic change which underlies the manifestation may be physical, chemical, biologic, nervous, or parasitic in origin.

Eighth. The manifestation may be physiologic or a symptom, or may be anatomic, showing a lesion or sign. The confusion of these terms is, unfortunately, common at present.

Ninth. Infections give signs and symptoms when they produce physiologic effects, and this forces us to distinguish between latent and actual disease. Other forms of latent disease—not infectious—must follow the same rule of classification.

Tenth. The increased accuracy and delicacy of diagnostic methods will continually change the conceptions regarding each disease.

There will remain so much that is unclassified that we must admit the propriety of maintaining the study of the natural history of disease as a science with a large content of philosophy requiring great mental training for its prosecution. This will contain much more than etiology or pathogenesis, will include all of physiology and pathology, and, if no better word can be found, may be called "nosology," though that term at present has the misfortune of being much abused. The danger of confusing the conception of a process with an actual objective reality has led to strange extravagances in the past, as when diseases were regarded as demons, and the morbific entity was almost as dominating an error as some of the concepts of modern bacteriologic philosophizings.

There must be a better discrimination between the subjective concepts or formulas, which are really what most diseases are today, from the actual objective processes and the manifestations.

The average man has a notion about what a storm is, but it is an extremely vague notion, and has surprisingly little in common with the conception of a storm in the mind of a meteorologist. The average medical man has a notion about diseases quite as vague as that of the average man about storms, and both would find it difficult to realize

that their conceptions were chiefly subjective and were largely composed of their sensations rather than accurate perceptions, much less scientific knowledge, of the phenomena or of orderly studies. When the science of disease begins to be cultivated the term may be made definable; at present this is impossible.

Dislocations or displacements may occur in many structures. While the effect is mechanical, the cause is often vital or chemical, though at times mechanical. Congenital influences often form a large part as predisposing to displacements of the organs or giving a tendency to ready dislocation at joints. Relaxed ligaments holding the parts in place may be acquired by a fibrolysis which may begin late in life. It is essential that we remember these predisposing factors when judging of the violence necessary to produce a given dislocation, and test the remaining tissues to see just how strongly they resist such violence.

Dislocation of organs may result from local conditions or disease, either forcibly displacing, overdistending, dragging by compaction of adhesions, or destruction of support. Dislocations of parts of joints may have been reduced after the relaxation of death. This I have observed in a number of cases, and such a condition could easily be overlooked, and this would be a serious error if the part dislocated had been the neck. The amount of damage may appear less severe after death, specially if the effect was due to pressure.

Diverticulæ of hollow organs are at this time receiving much attention, and their causes are the subject of considerable debate. To the congenital type we can attach but little significance, but to the acquired we have heretofore given too little attention, because there are apt to be very serious secondary changes in the parts, and the very formation of such pouches indicates grave conditions. This has been well studied in the class of diverticulæ of the arteries called aneurysms.

Edemas are very frequently met with, and their interpretation is necessary in most cases. They may cause any degree of tension of the part affected and always cause some swelling, even though the part may be smaller than usual after such swelling. Generally the contained fluid is clearly seen when the part is sectioned; sometimes it flows out readily. At times it may disappear after death by escaping into some cavity, sometimes it tends to settle in the tissues, usually it remains in place, a little may possibly escape by lymph-channels. The involved parts may be tense from distention or boggy, but if the edema has begun to be absorbed, or has escaped, the parts are apt to be flabby. It is very common to find the normal elasticity and resiliency much reduced. Edema and hemorrhage may exist together, and in late postmortem change this is common. The cause may be local or general or a distant local or a combination of several. Thus, local inflammation, general poisoning, cerebral injury, nephritis with vascular and blood changes, may either or several be the cause in edema of the lungs. The degree and distribution, taken with the other local and general conditions, give us the only safe basis for drawing conclusions as to cause.

Elevations form a very large and varied group of findings, some of which are taken up separately. It is important to note the location, size, shape, and consistency, and if multiple, their distribution. Superficial elevations are apt to be remains of past processes. Those involving adjacent layers require careful examination to determine their age and significance.

The essential characteristics to be observed, on which conclusions are to be based, will be color, tension, contour, demarcation, depth below surface, condition of base and surrounding tissue, as well as of the lesion itself. Contents, whether congested, inflamed, indurated, necrosed, softened, pigmented, fixed, or movable. The commonest cause is some form of irritation; their significance depends largely on the cause.

Emboli are commonly changed blood particles formed by coagulation or other disorganization on the walls of a blood-vessel, which becoming loosened are swept onward and plug either partly or wholly some more or less distant vessel. We should use care not to forget the path that must be traversed by supposed emboli. If this care were more general we would have far fewer emboli diagnosed.

Air embolism was more commonly diagnosed before the discovery of gas-producing bacilli. When any considerable amount of air reaches a cavity of the heart the result is apt to be serious, that organ exhausting itself rapidly by contracting on an elastic gas when it usually pumps an inelastic fluid. The oxygen is probably quickly absorbed, but the nitrogen is only slowly dissolved. Other substances occasionally enter the circulation through wounds of the veins. Too much stress is laid on fat emboli and too little on the effect of the fluids which occur in wounds.

Some day a careful study will be made of the effects of injecting into the circulation juices from crushed and injured tissues, such as are found in wounds; this will show us some surprising results, and we will then hear less about death by supposed emboli. We can at times find the source of emboli in some lesion and compare the thrombus with the remaining substance from which it was dislodged.

Emphysema is frequently found in the lungs, where it usually consists of an enlargement of the air-cells, but not rarely there is an actual infiltration of air into the tissue usually brought about by some violence. When the air-system is opened at any part air is apt to find its way into the surrounding tissues. Wounds of the neck, near its base or of the chest, often cause extensive burrowing of air into adjacent structures. Emphysema in the lungs of still-born children, as the result of artificial respiration, is not very rare.

Gas in the various tissues is commonly found after death as the result of decomposition resulting from the growth of gas-producing saprophytes, and it is found in life where there was infection by gas-producing bacteria. Such gas may be restricted to the region which was primarily infected or may be widely spread. The fermentation in the stomach and gut may extend very rapidly in certain cases, and in infections of the uterus gas production is quite common and may be extremely rapid. This probably accounts for much of the literature on air embolism.

Eruptions are generally considered with true skin disorders, but not a few are purely symptomatic. At times it is difficult to separate eruptions due to drugs and poisons from certain types of the infectious diseases. It is always pertinent to consider the distribution, extent, degree, and type of such eruptions, and when differences are found in areas of the distribution such differences are almost always of diagnostic importance. While one is apt to find too much definiteness in the descriptions and too little recognition of the variations that are found in different types, we must learn to recognize such types and their significance. I prefer to group eruptions as local infections, local manifestations of toxic conditions, general infections, neuroses, local irritations only secondarily infected, general systemic conditions not clearly infectious with consequent eruptions. Generally these groups can be determined by the examination of the body, except when two or more conditions exist together, which possibility must never be forgotten. Further consideration of this topic is to be found under Examination of the Skin, and Infections.

Excoriations may be due to violence, chemicals, or actual infection, and there is a possibility of their being simple sores resulting from irritating secretions, or from a still more vague cause, namely, devitalization of the tissue from occult causes. Many errors have been made as the result of hasty conclusions regarding these apparently simple lesions.

The breaking down of herpetic spots are at times difficult to distinguish from the denudations due to moderate violence, and either may become the seat of secondary infections, which still further increase the difficulty. Acrid secretions, more or less contaminated with bacteria, are perhaps the commonest cause, but one must exercise a degree of caution out of proportion to the apparent significance of these lesions in order to avoid grave errors.

Exstrophies often result from violence, associated more or less with some predisposing or congenital factors, the values of which must be arrived at by a careful study of the related structures. They require special care in dissection, so that the parts be not prematurely opened. The effects vary in the greatest degree, being nil in some cases and fatal in others.

Exudates.—Here, again, we have to consider the changed action of the protoplasm of the cell in exuding various substances under irritation or intrinsic change. The nature and amount of the substance exuded or secreted or excreted, and the effect on the parts into which it is passed, are quite as important as the condition underlying the process of production. Some of these exudates are watery and bland, while others are highly reactive, and may have marked chemical properties which are calculated to affect protoplasmic structures, and such reactions may be the only clues we have as to their nature, owing to our dense ignorance of the chemistry of such products of cell action.

One of the commonest effects noted is that of the precipitation of "lymph," so common in serous cavities. The secondary changes which occur in these exudates take place with varying degrees of intensity and

rapidity, so that the interpretation must be made with caution. We are often compelled to limit ourselves to the simple description of the findings without being able to proceed far with their interpretation. These observations should include color, consistency, texture, elasticity, tenacity, translucency, distribution, and any variations found.

Fat storing is a normal process which depends on the supply furnished by the digestive apparatus and the activity of the local tissues. Excessive fat storing is often associated with hyperalkalinity in the gut and is apt to cause mechanical interferences. Deposits of fat, often miscalled infiltration, have an apparent connection with disorders other than overfeeding; among these are certain nervous degenerations of a general type. Fat, being inelastic and compressible, acts as a cushion, tending to modify violence of moderate degree, but it yields to severe violence, fracturing or crushing readily, and is reconstructed slowly and poorly. Consequently, the effects of injuries to fat parts are widely different from those in normal tissue. The distribution of fat in the body, as well as its color, texture, and fragility, are to be observed. Fatty degeneration and fatty deposit may be confused, as is not infrequently done, because oil droplets found in cells do not always indicate a true degeneration. It is well to remember that fat deposit frequently goes with impoverished blood, and that nitrogenous starvation also shows itself in the tissues under similar conditions, so that fat is not an indication of the nutritive condition of the body except in a limited way.

Fevers.—In general, the fevers we are called on to investigate are due to infections, and these may be local or general. It is not proper to forget the hyperpyrexia of heat or the pyrexia of starvation, poisoning, and nerve disorders. The odor of the blood is often a most valuable warning that there has been fever in the body at or shortly before death. The fever odors are difficult to describe, but those who have had clinical experience will remember the peculiar type of breath odor that marks many of the pyrexias. These same odors are found on opening the body. We all have had the unpleasant experience of eating meat with fever odor and taste when the cattle have been driven or excited before being killed. Pyrexia is generally associated with more or less chemical change and often with congestion of the viscera. The distribution of the blood in such cases is often characteristic. In serious head lesions hyperpyrexia is very common. Unusual temperature of the body may suggest pyrexia, but one must not be misled by it, as postmortem conditions may be the sole cause of such findings.

Fibrosis, or fibrous deposit, is a very common condition, and does not depend wholly on inflammatory processes. There is often an increase of fibrous material in areas that have been the seat of inflammatory processes, but this is not even a general occurrence, and is found only in those of a limited group of infections, and undoubtedly depends on chemical conditions; so also do the generalized fibroses affecting all the organs and tissues. The material must come from cellular elements and be fixed or precipitated by chemical influences. This is very evident in fibroid phthisis. In contrast to the fibroses are found evident fibro-

lyses which, while much less often recognized, are none the less important. Such conditions are seen in tissue starvation associated with excessive fat deposits and in certain types of auto-intoxications.

Fibrous deposition is largely a matter of type, as seen in the race where it varies most. Some negroes show hyperfibrosis in many forms, while others show hypofibrosis just as clearly; the types are clearly marked. White persons show these types, but they are less striking. In the study of local deposits it is important to remember this typal tendency, so as not to misjudge the severity of the local effect.

Fissures and **fistulæ** are often treated with too little consideration at postmortems. They are not rarely the door through which serious infections enter the body, and, aside from the pain and exhaustion, they cause results out of proportion to their apparent importance.

Foreign bodies have an enormous literature, yet I find few warnings about a too hasty removal at the postmortem examination. They should be observed while in position, and the effects they produce noted and not guessed at. The finding of a body in the mouth, nose, or throat is not proof of its having been there before death, but certain evidence of fixation, reaction, compression prove what is otherwise only guesswork. Wherever the foreign body or substance is found we must consider the probable time it has been there, and the nature of the reaction in relation to the character of the tissues as well as of the substance itself.

Granulations appear less red and prominent, unless in dependent parts, after death. They afford some aid in estimating the age, condition, and secondary processes in wounds, and are to be studied as part of the wound and its surrounding.

Growths are to be interpreted by their position, extent, texture, contents, and the tissues they spring from. Their effects and causation vary greatly. They may be subdivided in many ways. They are generally hypertrophies, and often the result of irritation of the tissue. Whether they appear within the tissue from which they spring or as outgrowths depends almost wholly on the architecture of the part. The nature of the growth, however, will have some influence on its position and much on its physical properties.

Hardening is a result rather than a process, being found in many conditions. Simple edema may be so intense as to produce hardness. Induration may, therefore, be apparent or real. Actual hardening of tissue results when condensation and dehydration take place from any cause, or by the precipitation of fluid or semifluid albuminous bodies, or by deposits, as of lime. A little care will usually prevent one from mistaking tense swelling for true hardening of tissue.

Hernias have been considered under The Pelvis.

Hyperemias.—See Congestions.

Hypertrophies differ from growths by being more diffused throughout the structure and less differentiated. It is always a serious question how much of the apparent increase in bulk is due to the normal process of adaptation of the part to the work to be done, how far this is ab-

normal in itself, and how much the abnormality depends on a pathologic cause. The question of the composition of the hypertrophied organ is always to be considered, for many organs or parts show increase in bulk, but such increase may be entirely due not to increase of parenchyma, but to some tissue overgrowth, deposit, exudate, or adventitious swelling. A congested organ appears larger, heavier, and firmer than the same organ would be if it were not congested. One cannot be too careful in avoiding the mistaking of a temporary condition for a permanent one.

The question of hyperplasia and hypoplasia at times require the aid of the microscope, but generally this is not necessary, though it is always desirable.

The question whether the organ is or is not larger than it should be seems very simple, but a little experience and reading of records of postmortems show how easily errors are made about simple matters.

It is extremely common to neglect the comparison of the organ with the whole body before determining its normal size. One heart, weighing 600 grams, may be perfectly normal, while another, weighing 400 grams, is distinctly hypertrophied. Even the most careful comparison with elaborate tables of weight and measures, which include the theoretic proportions of the parts, will not be sufficient. One must judge of the normal work and of the pathologic work to be done by the organ in a given body; eliminate temporary changes of congestion, edema, irritation, and inflammation; and, after a study of the internal structure and physical properties of the tissues, arrive at an estimate of the amount of parenchyma that is found and its size in relation to the work normally required of it. This is anything but simple, and requires no little skill and experience. The question of hypertrophy should be approached cautiously.

Icterus.—See Jaundice.

Induration.—See Hardening.

Infarcts do not occur with equal frequency in all parts of the body, nor are there sufficient differences in the blood-vessels of the parts in which they occur to account for this distribution. It is clear that the common conception that they result solely as the result of emboli should be revised, not only because it is based on bad reasoning, but because we do not find (and have no occasion to suppose what we do not find) such emboli present in many cases. Local thrombosis we do find and emboli at times. The process is closely allied to all the other occlusions of the vessels, is more serious where collateral circulation does not exist, and leads to venous stasis if the process is sudden, and to anemia in the late stage or if the process is slow. Starvation of the affected tissue followed by necrosis is a necessary consequence, and if there is infection, and this is not rarely the cause of the process, the affected area becomes an easy prey. All such conditions require special consideration not only of the particular lesion, but of other parts that should be affected if emboli were the cause. The condition of the organ and the reasons for the same are always pertinent to the inquiry.

Infiltration is a term handed down to us from the days when cytology was unknown. It should not be applied to migrating cells, nor to fatty vacuolation in the cells, nor to any form of deposit, but should be restricted to accummulations of filterable fluids which pass into the tissue or substances by means other than secretion or excretion of the cells. Serum, blood, or lymph, or these fluids modified may and do frequently pass into the structures, and such collections are not true hemorrhages, though they may arise by passing from a hemorrhage into the surrounding tissues. The process may be an active imbibition by the tissues or simply extension through the meshes, or there may be something of osmosis. The occurrence of watery infiltration after large doses of normal saline solution is a common finding, and such conditions are usually spoken of as edemas. Secondary changes may and often do occur in these fluids. The products left in the tissues are deposits by infiltration, though similar deposits are more usually due to exudates. It will be apparent that I do not accept arbitrary definitions at variance with modern cytology.

Inflammations follow tissue irritation. They are transient after mechanical irritation when the source is removed, more lasting in chemical because the source is more apt to remain, and more or less persistent in infection because the cause generally remains longer. The inflammation depends, however, on the nature of the irritant; passes through a more or less regular course, consisting of a period of delay, of reaction, and of resolution or recovery; the speed of these changes varying moderately under different conditions in the same tissue and with the same irritant. The grade of reaction increases faster than the concentration of the irritant in most cases until the maximum is reached.

The tendency to confuse inflammation with infection is a serious error which should be avoided and combated. At the postmortem it is common to see but a small part of the evidence of inflammation remaining except where secondary changes have occurred; it is, therefore, necessary to judge carefully of what is left and to allow for the evidence which has disappeared.

Interstitial changes are best studied by noting carefully all the physical properties of the tissue. The microscope helps us to understand these only when we have observed them as a whole, but does not supply the whole data, for while it shows the distribution and quantity of what is left in the tissue after sectioning, it gives no clue as to its actual character.

Jaundice, or yellowing of the tissues, is perhaps the most striking example of how chemical substances from one part of the body pervade and influence all parts, and how such substances are taken up by cells and structures. The various types must be separated and the organs which usually are associated with each type subjected to special examinations.

Lymph.—See Exudate.

Macule.—This term formerly implied a considerable degree of per-

manence and has come to have chiefly a dermatologic usage; therefore the term **spot** is to be preferred for purposes of description.

Malformation.—See Deformity.

Membrane, or **pseudomembrane,** is a specialized form of exudate in which transformation has occurred. In examining such formation it is best to cut through a part after observing the whole, and before making any attempt to strip it from the producing tissue. At times it might be confounded with desquamation if too hastily examined. The way it coheres and adheres and the condition of the underlying tissue should be carefully noted.

Necrosis must occur when the circulation of a part is cut off by any of the possible conditions producing such tissue isolation. It also occurs after severe injury by physical, chemical, or infectious processes. It is important to determine the extent, the cause, and the effects. The fate of the necrotic area depends on the position and extent of the lesion. When on a surface the mass is sloughed out. When enclosed it may become a cyst or a nodule, in which various secondary changes are apt to occur. The rapidity of the primary process and of those which occur subsequently varies greatly with conditions, so that one must be cautious in estimating the age. The type of both primary and secondary changes will be determined by the tissue in which the area is located and by the nature of the cause, so that the findings often help us to judge of causes which have long since ceased to be active. It should be remembered that cells die at different rates and under different irritants undergo various changes before actually giving up life, and that they may develop vacuoles or granules or may exude reaction products which remain; also that after death they disintegrate or coagulate, depending on conditions.

Nerve lesions vary greatly in degree and kind, depending on the nature of the cause. Mechanical violence may cause bruising or severing. Inflammations may follow these, or other irritations and reactions may develop which may be seen and palpated, or which can only be discovered by the secondary changes they set up in tissues dependent on them for normal stimuli.

Lesions of nerve tone may arise from disturbances at the ganglion (producing) or in the fiber (transmitting), so that evidence of loss of tone requires careful neurologic analysis to accurately locate the lesion.

Many conditions found in the viscera depend on such nerve lesions far more than is generally understood, so that we must constantly be on our guard to perceive the nerve type. This we have more or less appreciated in connection with lesions of the skin and muscles, and to a lesser degree in glands, very slightly with regard to bones, and only very imperfectly in the visceral organs. The nerve supply of the organs is given at some length in the anatomies, but that these structures have functions that are capable of pathologic perturbations, and that these produce definite effects, seems to have escaped the attention of not a few pathologists.

The glazed thin skin, ridged finger-nails, muscular wastings and contractions of local groups, bone wasting, and many arthropathies point to primary nerve lesions, while all the general nutritive disorders are apt to affect the nerve tonus, giving rise to diffuse general signs of nerve conditions. Many special signs are found pointing to lesions of the brain.

In paralysis, whether due to central or transmission apparatus lesion, there is sooner or later a wasting, with signs of trophic lesions, in which there is a marked tendency of the tissue to break down.

If the paralysis is in the nerve the lesion is generally markedly different from the tissue surrounding the area of distribution of the particular nerve affected. Joint fixation, postural peculiarities, trophic changes, asymmetric contractions, are all conditions which should immediately put us on the alert to look for nerve lesions.

Edema of the lungs generally means either primary or secondary brain lesion.

The special dissection will be made in accordance with anatomic indications, and care must always be exercised to avoid a rather common error of confusing primary with secondary lesions of nerves.

Nodules are extremely common, so common that few postmortems are completed without the finding of such bodies. Often inconspicuous and of obscure origin, yet always significant if we can but obtain enough evidence to properly interpret them, their formation seems to rest on the principle that changes in tissues which have a normal resistance tend to become compressed, and compressed substances while viscid tend to assume a spheric form, and when the tissues react there is usually still more compression which intensifies the spheric tendency. The greater the reaction to the irritants, the more sharply round are the nodules, due allowances always being made for coalescing of nodules or for other architectural features which limit the rounding process. Nodules are seldom homogeneous, at least in the early part of their existence, but show more or less marked layering of the outside and a central mass, which may vary greatly in the same type of lesion. The type of the nodule is very often characteristic of the cause, as in tuberculosis, small-pox, or vascular atheroma.

Obstructions are mechanical interferences with mechanical functions. The findings at the examination should be clear as to whether the apparent obstruction truly represented the condition in life. Spasms in the intestines which occur at death in children may give rise to conditions which, had they existed in life, would have been acute obstruction.

The first question is, How much does it occlude or obstruct the part as found, and what would be the evidence found if the condition was the same in life as when seen after death? The forms of obstruction which change little at death generally show plenty of evidence of their action during life. However, there is not rarely a swelling above the place which is due to some other factor than the obstruction; thus, a swollen gut above an obstruction may have occurred by reason of peritonitis

and helped to exaggerate the effect of the old obstruction. It is generally necessary carefully to study the nature of the obstruction as well as the region in order to be sure what the lesion could and did do.

Occlusion may come from one or more of many conditions, either extrinsic or intrinsic. Obstructions without may wholly occlude a part, stenosis and atresia may close it, or some contained substance or part may fill up the lumen. An occlusion of an indifferent part, such as the opening to the appendix or of a sinus, is, however, a very different matter from an obstruction caused by an occlusion of the gut. The terms "obstruction" and "occlusion" have much common ground, but are too useful to be confused or regarded as synonymous. The occlusion may have occurred after death, as by clotting of albuminous substances, and by contraction of such clot we find that it no longer fills the lumen. When it formed it did occlude, but did not obstruct.

Papules are really incipient nodules of a specialized type, and usually indicate some infection, but may point to poisons, either endogenous or absorbed from without.

Parasites should be observed in position as far as possible, because the local influence is often an important part of the total effect. In the intestines they are usually readily seen and palpated through the walls. In the blood-vessels their importance often depends on the relation of their size to the lumen of the vessel. In the skin the local effects constitute most of their pathologic significance. Minute parasitic organisms are considered under Infection.

Pigmentation may be due to a number of causes. In the skin it generally results from irritation, but the amount varies with type of person, pregnancy, chemical conditions in the body, general diseases, and the severity of the local condition. A common mistake is to suppose that pigmentation following inflammation in the skin is always due to syphilis. Pigment in the serous membrane suggests former infection. Unusual substances deposited in the tissues may be classed as pigmentation. Care should be exercised to avoid mistaking such deposits for pigmentation by deposit of the normal body-coloring substances.

Staining by decomposed blood, by bile, or by chemicals should be easily distinguished. Dust accumulations, such as are common in the lungs, do not constitute true pigmentation any more than powder marks or tattooing. Discolorations of the skin or organs may easily be confounded with this condition.

Ptoses are really dislocations, but should be limited to those which are the result of yielding to the force of gravity. The essential thing to determine is, are the supports normal, for if they are, then some abnormal amount of force has acted. The question of production becomes a study of the balance of support and drag. Many displacements result from distention or dilatation, others from crowding of the part, neither of which conditions should be confused with a simple settling of the organ through weight or weakness, or both. The factors of nerve tone, chemical condition, and tissue vitality are too often neglected. Their significance is best illustrated by ptoses of the lids.

Pus occurs in three general positions—on surfaces, confined in pockets, and infiltrating the tissues. The way pus spreads in the tissues and the accumulations found tell us much about the chemical and physical and cultural properties of the microörganisms. It is easy to overlook pus when it is in an unusual place and the evidences of inflammation have faded after death. Gentle palpation has often saved me from this error. Where pus is the tissues usually have a different feeling.

No one who has had any clinical experience will be likely to mistake the induration of a carbuncle or the bogginess of a partly filled abscess for the tenseness of a full one.

When the deposits are small and the inflammation is not great perhaps the most useful help is the palpation of the lymph-glands, but the absence of enlargement is far from conclusive proof as to the presence of pus. A not uncommon error is to account for the spread of pus by burrowing and traveling in cases where it was the microorganism that migrated or spread, and the pus formed in new places rather than extended to them. Much surgical literature is seriously at fault in this matter.

It is a not uncommon occurrence to be asked "how pus got there," when the question should have been "how the microörganism got there." One not rarely sees a chain of pus pockets extending from a primary seat of infection in which the pus shows a marked difference in the different spots. In such conditions one finds a dirty mixed pus near the primary lesion, and a clear-colored pus with a definite consistency where the bacteria have been sorted by the tissues, and only the most virile forms have succeeded in reaching the spots well removed from the primary lesion.

I have seen such a chain extending from the anus to the edge of the ribs in the retroperitoneal tissues, where the progress was not through the lymphatics, but through the tissues. In such a case one can fairly well reconstruct the clinical history from the findings, even approximating the time consumed by the various steps of the process.

In the study of pus in the tissues one must always consider its distribution with relation to structure, sort of cells encountered, intracellular substances and channels, vascular peculiarities, lymph-spaces and vessels, and the type of pus found and other evidences of inflammation.

Secondary development of pus, where the bacteria have entered lymph- or blood-channels, is apt to show the type characterized as pure culture, while actually burrowing pus may be of this type if the cavity originally resulted from a single infection, but is apt to show impure or mixed types specially if the infection was primary or has been open at any time. At all times we must notice whether there is any attempt to wall off or limit the extending of the process, and, when possible, the age of such attempts judged. One should not forget the possibility of sterile pus.

Regeneration of tissue will be found to vary from the massive outpouring of lymph or callus to the almost dry adhesion found in primary

union, or union by first intention. The evidence of attempts at repair, both as to kind and extent, are very important as indices of the condition of the tissues and of the nature of the injury, but wherever evidence has a double meaning one must be cautious not to confuse the signs that point to one phase with those which point to the other. One must not rely on any one theory as to how repair takes place, but, after studying all the various methods that are known, apply such knowledge to the particular case.

Ruptures of tissues or organs take place through various mechanical means, and one cannot estimate the force necessary to produce the lesion in a given case without carefully testing the tissues involved. A friable spleen ruptures with a small fraction of the force necessary to fracture a hard one. So fat may be crushed to a pulp while the normal tissues will show hardly any effects. One caution is necessary, however, in regard to testing the force necessary to fracture an organ; postmortem changes tend to increase the friability of the pulpy organs, and the terminal exhaustion of the heart causes marked increase in its softness. The effects of the various ruptures must be worked out cautiously in each case, having due regard for the peculiarities of the tissues, the position of the part with relation to other organs and tissues, and the other evidences of force having been applied to the part, either directly or through other parts. Spontaneous ruptures of hollow organs may be due to internal pressure, weakness, or disease, or by reason of violence, or several of these factors combined, and it is often necessary to carefully estimate each factor.

Sclerosis.—See Hardening.

Senility is a well-recognized condition that is very difficult to define. It does not appear to be altogether clearly understood, but is often confused with changes that appear in the old or prematurely old. Thus, scleroses of certain parts are spoken of as senile changes, whereas many persons clearly senile do not show such changes. Anyone having large experience knows that senile changes do not affect all parts equally except in rare cases. The only conception of senility that is in conformity with modern scientific thought is one of a vital limitation, where the natural vitality of the part or of the organism as a whole has reached its period, and this limit is approached gradually and is noted by means of lessened activity of the protoplasm of the tissues. Among these activities are those which resist the various deleterious processes. The many conditions often miscalled senile changes are secondary processes which progress because the true senile change of vital powers no longer resists them. A car will run down hill when the breaks are worn, but not because they are worn.

Perhaps this may appear like a refinement, but we will certainly not arrive at clear conceptions of difficult problems unless we are willing to adopt such refinements of thought as are demanded by the intricacy of the subject, and I know of no subject in the whole range of human thought that requires closer methods of analysis than that of pathogenesis.

Softenings.—All organs become softer when deprived of blood, lymph, or the water contained in the tissues. I have seen anemia of a part mistaken for a true pathologic softening. Exhaustion of tissues by prolonged use often produces a similar softening—this is seen in glands and muscles. Wasting is another form of exhaustion where certain elements are no longer retained or maintained.

In considering soft tissues we pay special attention to their general texture as well as their structure and condition, to their vascular and watery contents; then we note any areas of special change, for it is very important to determine whether softening is local or general in the part or whether it is limited to the part.

Special sorts of softening are found where pathologic conditions exist. A plugged artery in the brain gives rise first to a softening of anemia. This is followed by that of exhaustion, and later on death and the condition we recognize as necrosis. Other forms of softening occur where actual necrosis has not yet set in, either by reason of atrophy, change of cellular contents, or of intracellular substance. So far as possible the qualitative and quantitative changes are to be observed, and interpreted, in the gross appearance, and by palpation, section, and testing of the physical properties, after which chemical and microscopic tests are to be applied.

Spasms form a group of contractions where certain muscles show marked fixation. Aside from those due to nerve lesions, we have purely muscular reaction to local irritation, which may be physical, chemical, or obscure. Thus, great heat, electricity, poisons, or local stasis with accumulation of irritant products may produce what corresponds to cramps in life.

General spasms are found in tetanus, rabies, strychnin-poisoning; these all leave more or less evidence after death. So also in children we find clear evidence of more or less general convulsive spasms, the cause of which may be in the central nervous system, in some reflexly acting irritation, or be wholly obscure. So far as possible we must select carefully from the conditions which might have been involved in producing the effect those which, under close scrutiny and reasoning, probably were the causal factors. Thus, the facial spasms of great abdominal pain give a well-known and characteristic expression which needs no very extended discussion of nerves or nerve-centers. Torticollis is so well known that one need hardly confuse it with a broken neck, as I have seen done more than once. Spasm of the glottis, which is so frequently the cause of death in drowning, is to be judged as much by its effects as by the actual closure found after death. Evidence of respiratory spasms are found in persons choked to death by a sudden obstruction, though it seldom remains after death, and the complex spasm of vomiting gives evidence of its having existed, though it is not itself found.

Spots of various sorts, shapes, and sizes are of common occurrence. A number of types which are more easily classified have been taken up in separate paragraphs.

A few suggestions regarding spots in general, and about indeterminate ones and those that have a composite make up, seem desirable. The old use of the word, signifying a blemish, mark, or circumscribed defect, has come down to us in spotted fever, milk spots, rose spots, etc. There is no other available word at present which enables us to temporarily designate an area of change more or less definite in extent whose nature we must investigate before we can give it an exact classifying name. We observe that there is a spot; then we determine its characteristics and, if possible, its nature and significance All this time it is a spot, though it may be of softening, of induration, of inflammatory change, of atheroma, or of pigmentation; it may be made up of any one or more of the possible changes by which tissues are affected. The term is more restricted as to size than area, always implies location and surface extension, and may have variable depth, but lacks roundness, as in nodules, and volume, as in masses, and applies to conditions perceived by palpation as well as those observed by inspection.

In studying spots we proceed in the rational manner by first noting all that can be observed without disturbing the tissues: location, size, shape, color; then, by palpation, determining texture, consistency, irregularities, surroundings. Often the nature of the lesion is at once apparent, as often it is not. Adhesions and hemorrhagic spots can easily be confused with various inflammatory conditions. Spots may prove, on study, to be bruises, stains, infections, burns, indurations, sclerosis, stasis, etc., but where several conditions coexist we had better, if we wish to retain clarity of thought, begin by calling the lesion a spot and qualify it as we obtain further data.

One form of spot deserves special attention in medicolegal work, namely, *marks*. These are spots to which special significance is to be attached by reason of causation or other value as evidence. They are sometimes equivalent to signs. Thus, birth-marks, pressure marks, excoriation marks, resuscitation marks, weapon marks, clothing marks, etc. Such marks are usually spots whose character indicates something of the manner of their origin, though various wounds are often called marks. The term "spot" is useful at the beginning of a description, and should be far more generally used, and would be if the average maker of descriptions was a little more self-critical and generally thoughtful.

Starvation is a rather common process, and may be local or general and of varying degree and kind. Children often show some form of more or less complete starvation, either by bad feeding or failure to use what is put in their mouths. General complete starvation is rarely met with. Substance starvation is vastly more common than one would suppose from the literature. I often see this in cases where some diet has been rashly prescribed in the hope of affecting perverted sugar or nitrogen metabolism. I have seen diseased organs actually starved to exhaustion and failure, with consequent death, because of an entire lack of knowledge of the physiology of nutrition of both normal and diseased tissues on the part of the clinician. If the diet is too much restricted in one substance the more nearly normal structures will appro-

priate all the body gets of that substance, and the weak or diseased organs will actually be impoverished or starved even to death. There is another common form of starvation which comes from restricting the flow of blood to the part, either by chronic or acute process. Starvation of the heart occurs in severe anemia, specially after great hemorrhages, or when the coronary arteries become occluded. Heart starvation is far from rare following surgical operations.

Fig. 253.—Starvation.

Note specially the posture of the head, legs and hands, sunken eyes, ridged belly. The keeper of the baby farm was convicted. Photographs were shown to the court and jury.

Stasis may be considered as any disturbance which affects the local motion of the fluids in a part. The blood-vessels may be at fault or their intrinsic or extrinsic nervous mechanism may be under some influence, either local, general, or distant. Heat, cold, fatigue stuffs and other poisons, violence, infection, or other inflammatory reactions may be the exciting causes. Stasis is not restricted to those cases where there is an accumulation of unusual fluid in the part, though such

accumulations may be the result or cause of a stasis. Various types of passive congestion belong to true stasis, as do lymph congestions. Even arterial congestion, where the vessels are full but the blood does not pass through in normal amount, may cause or constitute true stasis.

Congested infarcts are extreme examples of blood stasis, and many but by no means all dropsies indicate that there is stasis. This condition is very difficult to estimate at the postmortem, and requires the greatest skill in judging the value of each appearance and factor of blood, lymph and other fluid in the part, and of their position and condition, as well as of the physical condition of the tissues.

Stenosis is the reduction of the normal lumen of a hollow or tubular organ, and usually is restricted to certain regions or areas. Care must be taken to avoid confusing this condition with firm contraction of the muscles of the part under some irritant, constituting spasm; also to remember that certain scar-tissue may have a greater degree of resiliency or elasticity than the surrounding tissue. Thus, I have heard a firmly closed pylorus described as a condition of stenosis where the thumb passed readily on overcoming rigor mortis, which had occurred while the muscle was in spasm.

Where considerable increased elasticity exists, as is sometimes found in arteries, one might mistake the smallness of the section, specially if there was atheroma at this particular point, for stenosis, whereas on carefully distending the part we find that under normal blood-pressure the lumen was of normal size. When stenosis is found to be real, it is desirable to estimate its influence in the case, which will include not only the effect on the normal, but on minimal and maximal work of the involved or affected parts.

Swellings may arise from a number of types of processes, such as simple transudates, inflammatory transudates or exudates, watery or serous or bloody reaction to some form of violence or irritation, cellular or substance deposits, hemorrhage, cellular overgrowth, infection.

The character of such swellings depend on the tissues involved and the cause and stage of advancement, as well as type of process. The swelling that is limited by architectural peculiarities of the tissue may be suspected to be due to local causes in contrast to general swellings.

The presence of excess of fluid is so common as to be of little differentiating value, but the presence of other signs of inflammation with fluid is at least suggestive of a limited number of infections or heat. Fluid in which blood forms a considerable part suggests violence; the distribution and position will generally determine this definitely. Palpation gently practised before dissection and forcibly at the very last, after we are in no danger of destroying or changing evidence, gives us almost as much information as inspection of the parts. Actual dissection of a swelling often requires considerable care, both in planning and carrying out.

As a general rule, we should approach a swelling from one side, cutting well around the whole area until we gain a clear idea of what the relations of the affected part to the unaffected parts are; also the sort of

limitation that remains. Where the part is in layers, these are separated along their natural divisions.

If any seriousness attaches to what is apparently a bruise, it is well to cut a curved flap so as to include the whole affected area, and in such a direction as to facilitate dissection by layers of the underlying parts. Where the swelling is about a possible fracture or dislocation these flaps are located and planned to give free access to the tissues involved, and the layers are so cut as to be easily replaced in their exact positions at any time, and no tissue is to be cut wholly away until the very last stage has been reached, except in the rarest cases.

In simple swellings whose nature cannot be in doubt we may simplify the examination, but it is very annoying to have to resort to more elaborate dissection after having cut into something that should have been dissected out. This is specially unpleasant in cases of cysts, aneurysms, or hollow organs involved in swollen masses of unusual tissue. To prematurely open some collection of pus is more than annoying, as it interferes with our study of the way the collection is contained and limited, clouds the field of observation, destroys the evidence regarding tension on the adjacent parts, and compression of important structures.

On the other hand, there are exceptional cases where the best dissection is carving, by cutting carefully planned sections. This we have advocated in work on the brain, and in the pelvis it is also necessary where massive adhesions make dissection by layers or organs so difficult that the distorsion and compression produced overbalances the advantages gained. To open a cystic swelling of a duct before the whole extent of the duct has at least been palpated, and the effect of the tension on the gland has been determined, is always unfortunate. To open any part of a distended urinary system before the amount of filling of the various parts from the kidney tubules to the urethra is a misfortune.

Such swellings of organs as depend on obstruction or congestion are to be distinguished from those of inflammation and hypertrophy. Swellings due to hypostasis, dropsy, passive congestion, or varicose veins demand the comparison of local and general conditions.

Tumors, cysts, fractures, dislocations, and wounds may give rise to apparent swelling which is due to the size of the lesion, or may cause secondary swelling in addition, either around the part or at some distant point. Thus, a bullet wound of the pelvis or a rupture of the bladder may cause swelling of the leg or scrotum. It would show defective acumen to fail to recognize the cause of such secondary swelling, and to begin to dissect the leg before exploring the pelvis, as I have seen done. So swellings of the eyelids which follow orbital lesions; or arm in axillary injuries; or groin in toe infections, all require more than the hasty attack of the local problem. I find myself more and more disposed to judge the intelligence of both clinicians and postmortem operators by their skill in interpreting and handling swellings of various sorts.

Thrombosis occurs normally in cut vessels, and it is encouraged by the injury done to the vessel walls by clamps, ligatures, or applications. It occurs in various injuries to the vessels done by violence or disease, and is accelerated or retarded by the condition of the blood. Such clottings may be complete or partial, and, so far as they occlude the lumen, tend to cause grave disturbances of the tissues supplied by the vessel occluded. These effects are similar to those produced by emboli.

Thrombosis may be aided by stenosis, atheroma, roughness, or disease of any sort of the vessel, and may be determined by some temporary disturbance of the circulation. I have never demonstrated clearly such a case, but I am convinced that some of the emboli following operations are due to the injury done to veins, of which little account was taken at the time, the local thrombosis being unimportant by reason of collateral circulation, but the shrinking of the clot and subsequent contraction, separation, and transportation of the fragment give rise to serious effects. I have, however, found clots or thrombi in veins of parts too tightly bandaged in cases where death occurred from other causes. In case of thrombosis the nature of the clot and its internal structure, consistency, age, tenacity, color, adhesion to wall and extent, as well as the condition of the vessel and of the tissues supplied by the vessel, all have to be determined. When possible the cause is to be found.

Treatment marks deserve more attention than they usually receive not simply because of their local significance, which may or may not be great, but as evidence of the diagnosis of symptoms, such as pain for which a plaster has been applied; of the degree of care that has been exercised, or evidence of carelessness or of emergency practices which may greatly modify certain conditions, such as attempts to resuscitate after drowning, electrocution, or poisoning; of hypodermic medication which may have altered the action of the heart or other organs; of massive injections of saline solutions which dilute the blood, give rise to edemas, or dilate the already overtaxed heart; of antitoxins, which may be very dangerous in asthmatic cases; of flagellation in supposed opium cases; of hot-water bottles being too hot; of surgical procedures which may have had very important influence in producing the conditions found in the body; of home remedies, many of which are potent and can cloud the picture by their effects. Any one or more of these findings should not escape our notice and should put us on our guard.

Tubercles seldom escape attention, generally suggest if they do not prove tuberculosis, and are to be examined for size, consistency, contents, age, distribution, number, tissues in which found, and relations with other processes.

Tumors.—The discussion of the nature of tumors belongs to the works on pathology, but their dissection in the body is too often neglected in such works. Too much care is not likely to be given to the study of the relation of such lesions to the adjacent parts, and the comparison of the parts, tissues, and organs in cases where they are

found, to what should be the normal condition in the same persons. The dissection should only be commenced after the relations have been observed with regard to circulation, compression, adhesion, and other effects on nearby parts, involvement of lymph-spaces and glands, extension into tissues and metastases. All that has been said about swellings should be remembered in this connection. The problems of effect and causation should be brought into the mind in every case. The study of the tumor should be supplemented by microscopic examination, but not limited to such examination.

Ulcers when advanced seldom escape attention, but in their early stages may be overlooked. The condition of the part, the situation of the ulcer, the extent both as to surface and depth, the contents or covering of the ulcer, the reaction in the base below the ulcer proper, and the involvement of adjacent tissues and glands, all help to determine the type.

The type is far from characteristic of the exciting cause in all cases, and may mislead us if we indulge such a notion. The condition of the body as a whole has much to do with determining the type of ulcer that will develop from any specific excitant or infection. Secondary changes, due to neglect or treatment or other infection, may greatly modify the original type as well as modify the course and the effects produced. One must distinguish between the condition of the body which results from the ulcer and that which brought about the ulcer, and both from conditions of the body which are not causative but modify the progress as to rate and change of type. The tendency is at present to think too little about these and the many other problems which properly come to the active mind and should be dragged into the sluggish one.

Wasting, as an index of processes going on locally and generally, is one of the important signs we too often neglect. Absorption of fat, diminution of fluids, attenuation of muscle elements, relaxation of skin or supporting tissues, absence of color and decrease of tone, changes of resiliency, elasticity, and resistance, sinking in of areas, loss of contour, wasting of whole parts, atrophies, local anemias, these and many other types are not only to be noted and described, but actively considered in their connection as found in the particular body.

Their association in groups of which the values vary constantly bring up the questions of how much, where, why, how, what consequences result, and to answer such questions we must have some conception of the qualitative changes and the relative amounts of such changes, not simply for anatomic description, but for physiologic and pathologic values.

Wounds are chiefly of interest from a medicolegal point of view; though they may have no such relations. There is always the question whether they contributed to the cause of death. The fuller discussion will be found under Part IV.

INFECTIONS

Considering the great strides made in bacteriologic investigations, we are singularly lacking in knowledge of the gross culture appearances of the various infections in the body.

We are not always able to determine that there was an infection at the postmortem, nor are we sure of receiving the aid we most need from attempted laboratory cultures made at such examination. In many places where postmortems are to be made no complete laboratories for a full bacteriologic examination exist, and in such cases the operator is not sufficiently well paid to permit him to maintain such a laboratory if he had time and special skill to run it. It becomes necessary for those who are called on to make postmortems under such conditions (and these may be met with even in the larger cities) to formulate a method of detecting infections by the signs, and to interpret these signs as evidence of types if not of individual bacteria. Nor is this unnecessary or undesirable, even when the best facilities are at their command for full bacteriologic study, because the lesions produced by infections are quite as important as the bacteria, in most cases, as part of the complete study of the disease; in fact, most of the known infections were known by their lesions before the specific organisms were discovered.

The lesions of syphilis, tuberculosis, typhoid, anthrax, favus, the exanthemata, diphtheria, and of the pus-producing forms were studied and known long before their specific germs were isolated, and such study is by no means to be neglected now that we have methods of recovering the bacteria, either for the clinical or for the postmortem diagnosis.

The problems of mode of entrance, method of invasion, period of incubation, and the primary and secondary lesions are of even more importance since the recent additions to our knowledge of causation. The bacteriologic examination of any animal that has been infected includes the inspection of the exterior and interior, and of the organs and tissues, quite as much as it does the microscopic and cultural study of the isolated bacteria. The theories of immunity, of infection, of recovery, all depend quite as much on the accurate study of the body as on the quality or kind of germ involved. Few infections are of such overwhelming virulence that they are not modified by bodily conditions and treatment.

It is unfortunate that no master mind has given us an adequate comparison of the growth of bacteria in the various media in the human body in disease with the cultural properties as observed in the various media in the laboratory and made out the larger natural history of these forms. We are forced to search among a multitude of books and papers for meager scraps of information that we often need in our work and when we have little opportunity for such searching.

One wishes to know the meaning of the findings in a given case and what are the probable and possible causes, and what are the concomitant variations which appear with each, so that by differentiation he

PATHOGENIC MICRO-ORGANISM

NAMES	Bacillus Anthracis
AUTHOR	(Compiled)
MORPHOLOGY	SIZE 1-1¼ x 2-8 μ — SHAPE rods-square ends-to filaments
	MOTILE — FLAGELLUM — SPORE very resistant "only with oxygen" ENVELOPE "at times"
GROWTH—AT TEMP	MIN 12°C MAX 45 OPTIMUM 37 FATAL 60
" ON MEDIA rapid +	AGAR. + felted BOUIL. {sediment no pellicle} MILK + POTATO + SERUM + liquifies gelatin
	AEROB. + SAPROPHYTE probably PARASITE +
PRODUCES	ACID GAS COLOR — ODOR
	ENZYME + TOXIC SUBSTANCES + Toxines & "Alkaloids"
OCCURRENCE	SOIL and grass ANIMALS Herbivorous Cattle, Sheep, Horse &c. OTHER
IN BODY	OCCASIONAL — FLORA — DISEASE +
MODE OF ENTRANCE	AIR (+) FOOD (+) WOUND + MUCOUS MEMB (+) SKIN +
INCUBATION	24 hrs.-to several days — MIXED WITH probably at times
DISEASE PRODUCED	Anthrax or malignant pustule & internal (lung or gut) — with other forms
COURSE	generally rapid — (which accounts for varieties)
GROWTH IN BODY	SUPERFICIAL IN SKIN + IN M. MEMBRANE (+)
	LOCAL + LYMPH + BLOOD (+) IN CELLS INTRACELLULAR +
CAUSING IN BLOOD	LEUCOCYTOSIS HAEMOLYSIS INVASION (+) FIBRIN CHANGE
" PUS	PUSTULE (+) ABSCESS ULCER (+) SECONDARY DEPOSIT (+)
" ANATOM. CHANGE	SWELLING + OEDEMA + CONGESTION + HEMORRHAGE (+)
"	CELL DEPOSIT (+) HYPERPLASIA EXUDATE +
"	NECROSIS (+) GANGRENE rarely - by occlusion of vessels
" PHYSIOL.	FEVER mild to moderate CHANGE OF FUNCTION little pain - often itching
" POISONING	LOCAL + GENERAL (+) SELECTIVE
" SKIN LESION P	PAP +(1) VES +(2) PUST (+ 3) PIGM. ULCER (+ 4) SCAB (+ 5) SCAR
" " " S	+
" LESION IN ORGAN	AIR P. (+) L (+) S (+) INT (+) LV. P SP (+) K (+) SEX N. SYST.
" " VASCULAR	A. (+) V. (+) LYMPH. V. (+) L. GLAND (+) HEART (+)
" " MEMBRANES	MUCOUS at times SEROUS by extension (in internal A.)
P. M.	DEATH SPORE + GROWTH prob. EXTENSION ? EFFECT ?

P = primary
S = secondary
+ = Yes — = No
( ) = at times
here in intl. Ant.

Characteristic lesion. A Carbuncle with ring of vesicles may infect lungs or intestines when it usually invades the blood giving general sepsis.

may arrive at usable conclusions not only as to the particular germ, but as to its virulence and other variations, and as to rate of development. The difficulties grow with reading, consultation, and practical experience because the mass of data soon becomes unmanageable. In sheer desperation I was forced to elaborate an analytic schema or table by which I could abstract from the various authorities what would be of service, and then, by compiling a resultant from all the sheets, a general picture of the special germ might be brought together. I have thought it desirable to introduce one of these compiled sheets—that for anthrax—which was brought together from many authorities. I had hoped to be able to present tables from a full set of such sheets for all pathogenic forms, but the labor was too great for the time at my disposal. This picture of anthrax is not to be found in any single work, the most complete description found not giving more than two-thirds of the data required and the average text-book giving less than one-half. Each author selects a few fragments, but the basis of the selection varies in each case and has no special reason beyond the fancy of the author.

Thus, more than half ignore period of incubation, rate of development, different modes of entrance, production of fever, and mode of extension in tissues, than which nothing could be more important or essential.

Such an analytic scheme is practically of great help in gaining a grasp of the processes which underlie the lesions we find at the postmortem, and helps one to differentiate by such lesions between many of the causal infections.

When we look at a septic body there is something that tells the trained eye of that sepsis. To describe that something is difficult, but a few qualitative changes that are generally found may be indicated.

The color of the skin is changed to a putty yellow, and the lividity is generally of a dusky purple or old-rose color, and either more irregularly distributed or in extreme cases appears as a general suffusion. The translucency is rarely increased. The lips may have a vermilion color never seen in persons who died in fair health. The translucency found in certain anemias or in cachexias or late alcoholism is not found in sepsis. The expression of the face is often peculiar. Purging of bloody fluid from the air-passages is common in serious infections. There is usually a peculiar odor apart from that of the decomposition which is apt to occur quickly in these cases. The small hairs often show trophic changes. The elasticity of the skin is very commonly reduced, so as to be abnormally flattened or indented by moderate pressure. Often there is desquamation, sometimes purpura, and at times blebs. At times there will be no external indications.

The external signs are only of value when found, and their absence simply means that certain severe types of infection are probably not present, though other grave types may be. The facial expression of tetanus and hydrophobia are very characteristic, while the abdominal type found in recent perforations in the belly are characteristic, but not

so generally seen. The special advantage of detecting external evidence of infection is that it enables one to adjust the plan of procedure, and to be on the alert to secure desirable data or material for cultures.

Little need be said about superficial infections, such as ulcers, abscesses, carbuncles, boils, bed-sores, as they so readily attract the attention as to be seldom overlooked.

The involvement of the lymphatic glands, on the other hand, too often escape detection about the neck, axilla, groin, etc. The relation of glands to infection is dependent on the anatomy of the part and the type of infection, and when the glands are involved we must consider what infections probably produced the change, as well as its age and extent and virulence. It is to be remembered that several infections may coexist, one or more of which may affect the glands, while the others may not.

Many infections remain for a long time purely local, some become general, while others are always local; still others show no local signs. Of those which become general, we have several distinct types, such as malaria, tuberculosis, syphilis, where secondary local lesions more or less marked and characteristic are found; or such as typhoid, gonorrheal, pneumococcic, when the primary lesion is characteristic, but the secondary lesion is less markedly so; or such as rabies, cerebrospinal fever, where the primary lesion is not known, but the secondary lesion is clearly marked; or such as tetanus, diphtheria, small-pox, when much if not all of the general effect is due to toxemia, or to secondary infections entering at the primary lesion. In all problems of infection we must remember the variations of the flora of the different parts of the body and the reasons why these vary, as found by a study of their chemical and biologic peculiarities. The skin, mouth, nose, air-passages, stomach, intestines, sex organs, all harbor a large and varied flora in ordinary health, and may harbor forms which are only waiting for a favorable opportunity to produce an infection.

The cultural properties of these forms should be remembered if we would understand how they extend or pass on to a more favorable place for growth or infection, and the effect of congestion, secretion, moisture, denudation, or wounding in aiding in such infection.

When we find a lesion which shows that infection has taken place, we at once set about determining its extent and degree and what structures are involved. Then, how it came to be there, and, if possible, what systemic changes preceded and followed its development, and after a thorough study of all the findings we may be able to conclude as to the particular form of infection they are due to. The forms which give rise to simple types of lesions, such as tuberculosis, anthrax, and diphtheria, are usually easily determined. Syphilis, which gives rise to a vast variety of superficial lesions on the skin, shows a less wide range in the interior.

The sequelæ of infections at times assist us in this determination, but at times they hinder us. Many forms cause marked kidney change, some affect the spleen, and a few cause specific chemical reactions in the glands.

FIG. 254

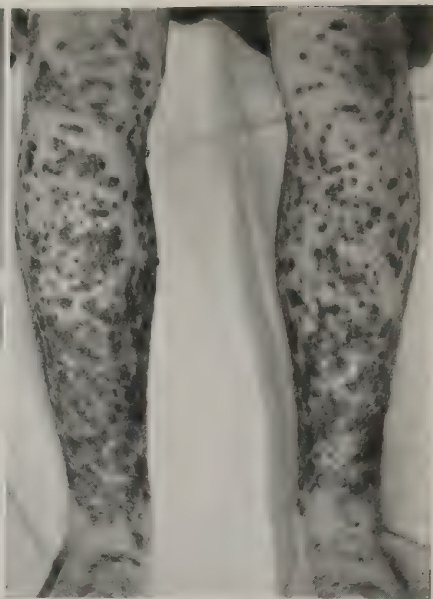


FIG. 255.

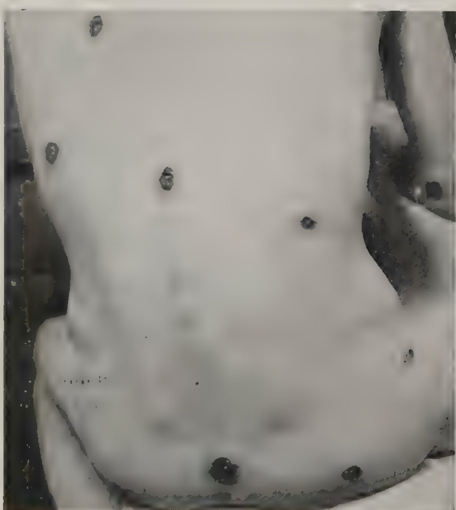


FIG. 256.

FIG. 257.

These show syphilitic lesions that could readily be confused with other skin lesions. (Courtesy of Dr. E. A. Schumann.)

Those forms which invade the blood are apt to show in the spleen, and, if they are pus formers, may give secondary abscesses which generally show a preference for certain tissues.

Thus, gonococci seem to prefer joints, while other forms find the best soil in the meningeal fluid. The question will often arise in regard to an infected area, whether the spread from the primary lesion was by simple growth in the tissue or by transplantation through the lymph or blood-channels. In the meninges three ways of getting into this position are common, through the nose, the ear, and the skin, and at times we can trace the path along vessels, nerves, or the sinuses, so that we must not be too ready to suppose there has been a general infection or a blood transmission. In interpreting a lesion it must be remembered that the virulence and other properties of the infection may change to a considerable degree while in the body, either by its own activities causing reaction, or by the changes in the body from various reasons, such as treatment, change of climate, food, exercise, or other diseases or infections.

The effect on the invaded tissues will depend on the physical, chemical, and biologic activities of the invading form and of the tissue invaded. Certain forms draw toward themselves cells from the blood and lymph, and this property seems to be due to chemical substances which may be called attractors, which definitely affect certain parts of the cell bodies, which may, in turn, be termed reactors; the results are grouped as ingestion (phagocytosis), secretion, destruction; that is, in certain dominant cells the bacteria are drawn in, while in less dominant cells the bacteria either draw out the substance or cause it to be extruded by irritant action; in others the reaction is death. We know that certain forms produce acids, while some produce toxic substances. We also know that both sterile pus and bacteria produce enzymes. This chemical warfare is carried on with rather definite weapons, many of which have been studied in the laboratory, but we too seldom apply this knowledge to the solving of the peculiar types of lesion found in the tissue. We must not forget that the effects are due quite as much to the reactors as to the attractors, and often as much to the results or products of the reactions. The cell full of abnormal products is no friend of the tissue in which it is thus lodged, and many of the lesions show this under the microscope.

HEMORRHAGES

Hemorrhages are separated by certain authors from edema by the presence of red blood-corpuscles. Such a definition may help us in our first steps, but soon fails in actual practice, because whatever leaks out of a blood-vessel has some of the properties of blood.

If the fluid contains fibrin-forming substances it may be called a lymphorrhagia. The older conception which the origin of the word hemorrhage carries is of a breaking out of blood, but we are often confronted by oozings that would not be classed as bleedings. It matters little what words we use if we can get clearly the conception

that fluids in tissues and cavities vary from almost pure water in cysts, through the watery edemas and the collections of serum, lymph, lymph with white blood-cells, to mixtures with red blood-cells, until we reach the extreme condition of pure blood, and that each result is an index of the processes involved. When we speak of hemorrhage we almost always mean the discharge of blood from a blood-vessel, yet, when we come to study an actual hemorrhage, we very often find it is not made up of pure blood. This is the rule in bruises, where the extravasated fluid varies greatly, and the understanding of the condition as well as the estimates of effect produced, time since it took place, and the cause all depend on a knowledge of these facts.

One could wish that the nomenclature of the subject had been brought up to our present knowledge of what is actually found. In the meantime we must content ourselves with the recognition of the types and let others find suitable names.

The types we will often meet with are—

(*a*) Filtering of the fluid part of the blood into the tissues (which may quickly escape into cavities).
(*b*) Leaking without apparent rupture of the vessel walls.
(*c*) Rupture of the minute blood-vessels.
(*d*) Rupture of arteries containing blood under low pressure.
(*e*) Rupture of arteries carrying high blood-pressure.
(*f*) Rupture of veins and sinuses.
(*g*) Rupture dependent on violence external to the vessels, causing wounds of the vessel walls.
(*h*) Rupture caused by external violence which overdistends the vessels, thereby causing bursting.

One cannot closely consider the bleeding found in hemophilia, purpura, asphyxias, poisonings, infections, menstruation, nose-bleeding, and bruises without being impressed by the actual differences of type, nor can one hope to solve the problems presented by the multiform lesions found without much study of the chemical, mechanical, nervous, and biologic factors of the circulation.

We can, of course, study only the gross macroscopic findings and ignore these difficulties, and it is often perfectly proper to do so, specially when the findings clearly show that some massive hemorrhage has a very definite and simple cause or the effects are of secondary importance. There will remain a very considerable number of cases in which we cannot solve the problems in any such easy way. Then it is that everything counts. We must remember what possible changes in blood-pressure can do in the particular region affected. We must understand the difference between an osmotic extrusion of watery fluids and a transuding of substances which do not simply pass through animal membranes, and we must grasp well the fact that cells under peculiar excitation can and do give out as secretion or excretion varying fluids, which if they also have red corpuscles and coagulable proteins we regard as hemorrhages when found, even though we find no ruptures. The frequency with which we meet these mixed fluids in what are called

hemorrhages is surprising when we consider how little is said about the subject in the text-books, and we must consider modern discussions of the subject as eminently unsatisfying.

The hemorrhages we observe will have size either by reason of their spreading in the tissues, by the mass of blood in cavities, or by the amount lost. The rate at which they took place, whether slow or rapid, and the sort of flow, whether interrupted or continuous, and the varying effects from these differences generally should be considered, though it is not always necessary to devote much time and attention to such details.

The amount of pressure under which they occurred can at times be judged by their source and at times by their effects.

The significance of a hemorrhage will depend on the structures affected, and on the relation of the blood lost to the amount which can safely be spared by the individual in the condition in which he happens to be. These conditions vary with sex, age, and disease, and with the total amount and quality of the blood which he has. Thus, a few drops of blood about the larynx may show that a man was murdered by throttling, a few ounces will cause death if shed into the brain, but several pints may be lost at childbirth without very serious danger.

The effects of hemorrhages may be grouped into—

(1) The compression produced in tissues or organs.

(2) The disruption of parts (as in aneurysms and apoplexies).

(3) The obstruction, as in the lungs.

(4) The anemias, either general or locally in the vital organs.

The place where blood is found is often misleading, so that it is necessary to carefully consider how it could have gotten where it is. This is particularly true in the digestive tract.

The age of a hemorrhage may often be determined by the condition of the blood or clot, and in old ones by the staining of the surrounding tissues.

The amount and rate of absorption of blood shed into tissues and cavities varies greatly in different parts of the body and in different individuals, and under different conditions in the individual. An old hemorrhage into the brain may show a yellow stain years after it occurred, whereas a skin hemorrhage usually clears up in a few weeks. The fate of hemorrhages into the peritoneum is not wholly clear, but it seems probable that extensive ones have cleared up rapidly. In the aged they spread further and last longer than in the young.

The anemias following serious hemorrhage are not infrequently overlooked clinically, and one is apt to find dressings soaked with pale blood or with a fluid in which the blood is only a small portion. In such cases it is well to remember how much fluid it takes to wet a yard of gauze to the degree found in the dressings. I have surprised quite a number of surgeons by demonstrating this by taking dry gauze and allowing it to soak up water in a graduate.

The appearance of the body should tell us at a glance whether there has been severe hemorrhage or not.

Finding the bleeding point is more difficult after death because the opening is generally smaller by reason of the elastic and muscular contraction which takes place as the blood-pressure decreases at death, and such contraction may have taken place during life and actually stopped the hemorrhage some time before the effect proved fatal. The cause of death is sometimes cerebral anemia and often acute starvation of the heart, which may take place very quickly. The anemias of disease usually differ markedly from that of hemorrhage, but rarely one may be in doubt. In such cases the condition of the organs helps greatly.

Postmortem loss of blood may confuse one, but such cases are rarely seen, because there must be a large open wound and the body must drain toward that wound. I have seen a few such cases, and in several the anemia was profound and wholly due to postmortem drainage or bleeding. Usually there is some part of the body which did not drain, and that part was not so markedly empty of blood.

When there has been an internal wound or rupture such postmortem bleeding may lead to serious error if one does not carefully investigate the problems of bodily drainage and the condition of the blood and clot found. Some very striking errors have been made by those who supposed that all the blood found in such a case had been shed before death.

I have seen cases where the death was instantaneous from shock, but where several quarts of blood and clot appeared in the cavities. The matter of postmortem blood-pressure has already been considered; this has an important part in postmortem bleeding.

The rate of flow of blood in a hemorrhage naturally varies with the size of the vessel and its degree of contraction.

The contraction of the vessel depends on the nervous impulses reaching it, the blood-pressure forcing it open, and the local irritation which tends to affect directly the muscles of the walls. The distance from the heart and the force of the circulation determine the blood-pressure.

The viscidity of the blood is usually about the same, but as hemorrhage proceeds, this is apt to vary, and after large injections of saline solution the viscidity drops, thus defeating, in part at least, the object for which the saline was given, if given before the bleeding points have been secured. Such temporary methods may, therefore, serve to wash out the remnants of blood so that recovery is impossible. Another common result of this forcibly produced hydremia is to greatly increase the power of the resulting fluid to pass out through the vessel walls and mix with the tissues, there producing edema; or if blood be present, also to cause an appearance of greater hemorrhage than actually exists.

Hemorrhages tend to terminate by contraction of the vessels and the formation of clots. Such clots may exist in the ends of the vessels, or may be applied on the outside in such a way as to compress the bleeding vessels. Hemorrhages into the tissues do not always show a general distribution such as could be accounted for by general increase of blood-pressure; thus, in asphyxia we find them in the thorax oftener than elsewhere. Bleedings from the mucous membranes, such as those of the nose, mouth, stomach, intestines, often occur where there is not suffi-

cient increase of general blood-pressure to cause them, and where the elements of infection and injury are clearly not present.

One must not forget that determination of the blood to the part plays a very important part in certain hemorrhages. In such areas of determination the blood-pressure is raised or lowered, depending on conditions. Determination of blood to a part is an extremely common physiologic occurrence, and it generally precedes and accompanies the normal action of the part. Bleeding occurs more readily during such periods. In local spontaneous bleeding it is always necessary to consider the probabilities of the occurrence and degree of such determination.

Mechanical conditions, such as are found in the thorax, at times play a considerable part in the amount of blood, as well as in the rate of flow and the distribution of the bleeding points.

Sudden compression of large vessels which are well filled cause a sudden increase of intravascular pressure which alone accounts for many hemorrhages we find at the postmortem. Aside from the normal variations in the local blood-supply there are many distinctly pathologic variations where the vessels are overfilled. The picture in such cases is different from that presented even by extreme attempts at physiologic action. In studying local engorgements one must remember that they often arise from stimuli at points more or less distant from the bleeding area. This is specially noticeable in pancreatic congestion and hemorrhage, which is apt to occur when the stomach is strongly stimulated. In toxemia the effects are more apt to occur in the tissues most sensitive to the poison or in parts governed by such tissues. Uterine hemorrhages may show one or many of these various factors, as well as those inherent in the part, as seen in menstruation.

No one can master the whole subject without considering the many types of bleeding. A study of these shows how the various factors act in each type.

The more striking factors may be summarized as—

(1) Blood tone or composition.
(2) Vessel tone, including condition of walls, and the
(3) Vasomotor mechanism, which reacts to
(4) Various reflex stimuli from the organs.
(5) The tone or condition of the surrounding tissues which support, compress, or otherwise influence the vessels.
(6) Various chemical substances in the blood not normally present, or, if present, normally only in markedly different quantity. These may be autogenous or exogenous poisons.
(7) Diseased conditions, causing variation beyond the limits normally found in any of the other groups.
(8) Blood-pressure, whether resulting from vascular or cardiac conditions.
(9) Local conditions, as heat, electricity, infection, toxic action, or violence.
(10) Such distant factors as may set up any of the above conditions, as kidney lesion, crushing violence, or blow.

Sorts of Hemorrhage by Free Bleeding.—Arterial shows bright color, and if vessels of any considerable size have been cut there may be spurting, though this is not infrequently hidden, as in deep wounds where the stream has impinged on another part of the wound. The marks on the surroundings require careful study, because a drop of blood may be thrown by many other means than by the arterial spurt. Venous bleeding may soon resemble arterial by reason of rapid absorption of oxygen or in cases of carbon monoxid poisoning. Massive hemorrhages without any source being found are not rare in the interior of the body.

The amount of hemorrhage may be variously estimated:

(1) By the presumption of loss from the condition of anemia found. This, of course, is open to grave errors, and should be made guardedly and corrected when possible.

(2) By the blood found to be lost—

(*a*) In the cavities of the body.

(*b*) On the clothing or dressings.

(*c*) From the detailed accounts of those who observed it.

(*d*) On the surroundings.

Perhaps few realize how easy it is to be in error regarding such estimates, yet they are of vital importance to the surgeon as well as to the pathologist and medicolegal expert.

The quantity that can be absorbed by a given amount of cloth is generally greatly underestimated. Dressings of gauze take up large quantities. A 5-yard roll of surgical gauze will take up 10 ounces of water. The amount of blood will be somewhat less, but in large dressings which are well wetted it is safe to say that an ounce to the yard is well within the truth.

The effect of hemorrhage on the body is first to remove the blood from the vessels generally, thereby reducing equally the amount of blood in the organs, so that a congested organ may appear nearly normal or even anemic; the color of the organs will be less red in proportion to the extent of the loss of blood. The organs will become drier, provided no injection of saline solution has been made. The remaining blood becomes lighter in color, clots more readily but less firmly, and the clot is light in color. The heart becomes contracted, and if the loss was serious is apt to show signs of quick starvation, and may be pale and easily torn. Lividity becomes sparse, the mottling more marked, and the colored areas more widely separated and smaller. The body usually keeps better.

Secondary changes in the seat of hemorrhage: Clotting is general, and the quality and shape of this clot varies greatly, as does its consistency. Single large hemorrhages show usually a large clot molded to the cavity or receptacle into which they have occurred. Several successive hemorrhages may show a stratified or layered appearance, or at times they lie as masses separately or adjoining.

Continuous hemorrhages are less apt to be clearly outlined. All these may be disturbed by movement of the organs. Hemorrhages into

the confining spaces, as the mediastinum, retropleural and retroperitoneal areas, often show no separate clotting, but the whole mass of tissue and blood seems to set together in a way that makes dissection difficult.

Arterial hemorrhages into tissues give evidence of the violent pumping of the blood column behind, and the dissecting effect resulting depends on the tensile powers of the tissue to resist. This is seen to be very variable in different parts of the body, and to depend also on the zones of blood-pressure. Thus, in an old person the blood may go a long distance with very low blood-pressure.

I remember a case of a powerful man who died from a rupture of a muscle in the lumbar region which caused a hematoma containing several pints, but this was entirely circumscribed, though the heart was very powerful, and neither the rupture nor the anemia were diagnosed during life.

It is desirable to estimate the bleeding area and the probable blood-pressure at that spot, and to judge of the relative arterial and venous elements as well as to calculate the oozing. It is not wise to attempt to be too exact, because many factors enter into the problem, and any one of these may vary in an unknown way so as to entirely vitiate the calculation.

Practical experience has shown me how many mechanical and physiologic accidents may occur to modify the probable rate of bleeding from most of the arteries of the body. I well remember a man who was stabbed in the chest, who died under the eyes of a skilful surgeon, and whose only serious cut was in the left internal mammary artery. The wound suggested a bad heart cut, and every one present wondered that he lived so long, but at the postmortem we all were surprised that he had died so soon.

The amount of blood that can be lost varies enormously, and any definite statement is to be made cautiously. In general, a rapid hemorrhage is more serious than an equal one that is more gradual. One man will die before he loses a quart, while another will recover after losing several quarts. Sometimes we can determine why this was so in a special case.

SHOCK

One is astonished at the attempts of persons, who have not thought it necessary to study modern psychology and nerve physiology, to develop accounts of this interesting phenomenon. The literature is growing in an appalling way, but much of it gives all too positive evidence of entire lack of grasp of the fundamental principles of physiology of the nervous system. Pain is confused with the specific sensations; reflex effects, such as the inhibitory impulses sent to the circulatory apparatus, are hopelessly mixed up with nerve-cell exhaustion. Were it not a common occurrence for one busily working in postmortems to have cases where shock was a most important factor, I would much prefer to be silent and smile inwardly at all this confusion, but my own cases so frequently demand answers to the problems of shock that I feel it worth

while to attempt to present the matter simply, knowing all the while that it is very complex.

Shock is considerably older than the human race, and I find more profit in a study of the history of shock, or of shock in history, than I do in reading the very sophomoric observations of certain laboratory workers.

History is full of accounts of how shock has been overcome or prevented. The martyrs withstood injuries quite as terrible as those devised by misguided laboratory workers. The Spartans knew how to conquer pain and shock as well as our American Indians. The flagellants, fakirs, and other devotees became completely successful in controlling shock. Tribe after tribe of wild men have learned to undergo torture.

War has always shown examples of persons who, by art or accident, had this power of controlling the effect of injury which would normally produce severe shock.

Does it seem quite reasonable to ignore all this vast mass of common knowledge simply because it happens to be the fashion to study only the vaporings from crudely pedantic laboratory experimenters? Before the development of our knowledge of what is called hypnosis our knowledge of shock and its control was not organized according to the rules of modern science, and even today much of it remains to be so organized. The practical methods adopted by those who were successful in gaining control over shock were apparently quite different, but all had the one fundamental principle of control of the attention.

Whatever else the attention may be, it is primarily the function of disconnecting the paths of a vast number of incoming impulses or impressions. I cannot pay attention to this page and receive the hundreds of impressions that are waiting to rush into my mind cells from all around, both from my other brain cells and from the sense organs of various parts of my body. All control of shock in historic and prehistoric times has depended on the attention or power to disconnect afferent impulses. Of course, the impulses to do things (say things included) are similarly dissociated.

Now all this has been about the higher brain cells associated with consciousness, but there is no law for one group of nerve-cells that can be separated from other nerve-cells. I would not hold this pen unless my attention extended to the very last nerve-muscle plate in my fingers.

There is a physiologic attention which means accurate automatic connections, with just as accurate automatic disconnections, along the whole nervous path, from eye to brain and from brain to finger. Mystery enough and to spare there is in all this, but the principle is very simple, and we depend on it in every act of our lives.

I find great profit in the study of the telephone in all this field, for it shows me how the human mind has worked out the problem of communicating information over connectable and disconnectable paths, and has stumbled on methods long used in the animal body.

If the lightning strikes a telephone cable there will be a burnout

somewhere, either at central or at the end of the line, or both. Such a burnout is not so very unlike shock in the animal body.

Too often I find that it is forgotten, or not known, that there are currents and differences of potential in the nerves which will give rise to currents under proper conditions. These differences of potential are normally maintained throughout the whole system, producing a nerve tonus. This is not unlike the actuating current of the telephone. Serious alterations in this potential will be transmitted only when connections are made. Now, in animal bodies such connections are automatically made unless there is that something we call "attention" which controls by intentionally disconnecting them. Then only the most powerful impulses can cause the path to be opened, and where the attention has been trained, as in great stoicism, even the strongest calls are not let through.

Pain is very different from ordinary sensation, and has a far greater power of working the automatic machinery to establish connection from the surface hurt to the higher centers, and attention must be highly developed to check the cry of the injured part in its insistent rush to the centers. We see that there are all grades of ingoing impulses that naturally tend to pass upward. Some persons have crudely confused inhibition, which is a positive motor impulse which passes to a part, with this dissociation which cuts off the part either wholly or partially.

The cultivated man does not inhibit his stomach, though he may forget it by simply dissociating it from his mind, while the boy finds this quite impossible. Of course, the surgeon who thinks only in terms of instruments, operations, and drugs finds such thoughts as these a foreign language, but the surgeons of today will be replaced by a different sort of persons who can think on those things requisite to their art.

Practically, we find a wide range of injuries which send up messages that produce a symptom-complex which we call shock. This symptom-complex is primarily nervous and subsequently visceral.

The degree of shock is not always in proportion to the injury done, and this has been a frequent stumbling-block. If the injury was sudden, and one has had no warning and no time to prepare for it, the paths fly open and the shock is greater. If this damage reached the mechanism of the attention no dissociation will be possible. You run into a door in the dark, you suffer intensely and feel sick, and your nose bleeds, but you probably had worse blows on the nose while boxing which yielded vastly less shock, both because you prepared yourself for them and because you had learned to ignore the effects after receiving them.

Some persons seem almost destitute of attention of this sort, while others have developed it to a high degree. No football game is played without striking examples of control of shock by certain players. When we come to surgical operations or other violence of an extreme sort we so pass beyond the trained attention of our subjects that it fails, but we see some persons even now, and in the days before anesthetics they were often seen, where even major operations were gone through with

and astonishingly little shock was noted. It is, therefore, necessary to consider the suddenness of the injury and the degree of preparedness of the subject in all questions of shock.

The effects of shock are often disseminated by what we call irradiation, or spreading through accessible pathways, and this will vary in each case, and here is where analysis fails, because no one can say what paths were open or openable. This diffusion of disturbance of nerve tonus is very like the spread of a high-power current in a telephone station where dozens of lines will be disturbed, and the whole actuating current mechanism will be affected so as to be felt whenever a connection has been made, or perhaps it is more like the loss of actuating current when the wire is grounded.

Such dissemination will always reach the sympathetic system, and the vasomotor changes will generally be marked.

The whole protective mechanism will be set in action to prevent hemorrhage such as would be likely with extensive injury. This, of course, means lowered blood-pressure and muscular relaxation.

Much confusion has arisen regarding shock by reason of slovenly thinking, which does not separate primary causes, nervous results, and secondary phenomena.

Pain is so generally connected with shock that one of the commonest errors is to associate them as if they were the same or at least part of the same thing. We may suffer great and prolonged pain without any shock, and, on the other hand, a laceration of the brain, which is quite painless, will show plenty of shock.

Pain, being a special sort of sensation, is like other afferent messages in its independence of shock. Nor is it proper to try to measure the amount of shock by the pain observed.

Another source of confusion is confounding exhaustion and shock. Exhaustion may be hastened by pain, by shock, by hemorrhage, by drugs, whether used in therapeutic innocence or with full intent to produce "physiologic effect."

Many of the phenomena associated with shock are due to exhaustion or to hemorrhage. One hears too frequently the thoughtless phrase "shock following hemorrhage."

It is imperative, if we are to use these words, that we do so at least with a semblance of intelligent appreciation of what they mean. If there is confusion regarding the parts played by shock, hemorrhage, and exhaustion, one had better determine what is wrong with one's conception regarding each, before going further into error.

I have no objection to calling shock a nervous hemorrhage if it helps one to grasp the idea, but destruction of nerve tonus is better.

There is one advantage of thinking of shock as of a "nervous hemorrhage," it makes it easier to conceive of secondary flows or leakings. One feature of attention is that it wearies, so that if the source of this nerve leak is continued shock is apt to become evident.

The mechanical or chemical blocking of the path by which such causes act by means of injections into the nerve sheath, or infiltration, will be

apt to greatly lessen the first effects, but if the causal condition, as a bad burn, remains active one finds cumulative shock developing after the nerve-blocking has worn itself out or passed off.

One confronted with a dead body where there has been shock must consider certain matters most carefully:

(1) The extent of the lesion wherein shock was produced.
(2) The probable time of action.
(3) The severity of injury (*a*) in actual mechanical violence; (*b*) in resultant tissue injury; (*c*) the peculiar sensitiveness of that tissue involved.
(4) The nature of the effects following, such as continued nerve disturbances.
(5) The significance of all other contributing factors, such as hemorrhage, previous condition, and other mechanical effects.
(6) Whether the violence itself produced nerve-blocking.
(7) Whether any preparation to resist shock was possible.
(8) The actual findings of a physical sort, consisting of the careful study of the location of the blood in the skin, lungs, and viscera.
(9) A minute study of every bit of history obtainable as to the effects before death.
(10) Finally, a realization that clear thinking is apt to appear as theorizing to the laity if not to the mass of the profession; therefore never say shock unless you have very definite reasons for it, and don't worry about medicated pseudopsychology, much less physiology, from the petty viewpoint.

When you know great injury exists, or can see clearly that peculiar injury to a sensitive zone has existed, you must say shock, and support your contention as simply and forcefully as possible.

Remember that there is no inherent mystery about the subject, and that you will get much help in comparing breaks in electric apparatus with those in nerves; that a cut or blocked wire carries no messages; that mangled apparatus may send all sorts of noises up the wires; that any potential-containing conductor can leak badly enough to cause serious current trouble at headquarters.

Do not expect to find the body after suffering shock to show signs of a sthenic death, nor yet of the vascular upset so often spoken of, specially if there has been hemorrhage. The characteristics will be of an asthenic death unless extreme massive violence was exerted. In severe crushes or blows involving filled blood-vessels one finds effects that mask the typical picture of asthenic death.

The heart may be in any condition, but where shock was the main factor the heart muscle will retain considerable tensile strength, resisting tearing very differently from one where death was by hemorrhage with true heart starvation.

The two common asthenic deaths are by exhaustion and by shock, and it will often require very close and careful study to determine how much of each has entered into the particular case.

The conception of "nerve hemorrhage" will at times help us to realize the difference, as will also the conception of a battery, which may be run down, but not used up. The condition is chiefly one of spentness; shock is the temporary effect which uses up the kinetic energy, but there is yet the potential energy to draw on, while in exhaustion the potential is gone as well. It will be easier if one has intelligently studied the whole automatic and subconscious nervous system to understand what such lowering of the vital nervous potential will produce. Such an understanding would have helped medicine greatly, and incidently have prevented the appearance of most of the literature of shock.

PART V

MEDICOLEGAL POSTMORTEMS

With the gradual growth of civilization the importance of the medical sciences as a basis for all rational organization of society will be more and more recognized. The more intelligent part of the community is already beginning to understand the practical value of preventive medicine in the regulation of everyday life, and as time goes on the scientific part of medicine must receive an ever-increasing appreciation.

Instead of the medical profession having to fight or beg for the examination of bodies of dead persons, the enlightened public will come to demand that postmortems be made more often and more systematically, and with the highest skill, in order that the lessons to be learned may be gathered for the benefit of both the well and the sick. Medicine is destined to grow to be a part of the State. The term "State medicine" has certain advantages even now over that of legal medicine, but at present the latter term is more generally understood, and it conveys more definite ideas, specially in the field of postmortem work.

At present the law not only sanctions certain postmortems for its own purposes, but directs that examinations shall be made in certain cases. Certain officials are instructed to have such examinations made in the interest of the community.

The existing laws vary considerably in the different States, but the tendency is to increase the number of such examinations and toward a greater uniformity of practice.

With the increase of facilities and the improvement of technic the prejudice of the public against such examinations must decrease, and this, with a growing realization of the benefits to be derived from a broader policy, there can but be more of them made.

The public will not be slow to appreciate the fact, however, that it is not a question of more badly done postmortems, but of wisely done ones, which will be of value.

If the medical profession disregards this sensible attitude of the thinking public, and continues to advocate simply more postmortems rather than better study of the cases, progress will be very slow.

At present the law directs examination to be made to determine the true cause of death, to determine the extent and cause of injury, and to throw light on cases where crime is suspected. It indirectly encourages such examination as will furnish evidence on which to judge whether certain contracts were properly made or are being legally fulfilled. This

is specially to be found in matters of insurance and compensation for damages received.

The three great groups of legal medicine which concern us are: (*a*) registration of vital statistics, (*b*) civil medicine, and (*c*) criminal medicine.

The growth of the regulation of industries is already increasing this class of civil postmortems, and as the great communities swing into the ranks of progress the system of thorough investigation of industrial diseases and injuries will rapidly spread and the industrial postmortem will become an important branch. At the present time the development has but commenced and hardly warrants extensive treatment.

Boards of health were largely created to prevent epidemics and record the causes of death, but are now taking up all phases of preventive medicine and utilizing the data obtained from vital statistics for this purpose. It is necessary that the records of the causes of death should be as free from error as possible, and to this end in some communities the inspectors are authorized not only to make visits to the sick, but also to make postmortems. Unless such work is done along the lines and in harmony with modern improvement, we are but increasing the number of such examinations without a utilization of the opportunity to advance knowledge, consequently such hasty routine work tends to do as much if not more harm than good, for the hurried work of poorly equipped inspectors will be of little value, and the workers will become careless and will degenerate into faulty habits.

Such work should, if done by agents of the board of health, be confined to those who will and can specialize, and must not be crowded on those already overworked.

The willingness of unprepared and ignorant persons to make postmortems for the State in any capacity has brought great discredit on the profession and on the offices for which such persons work. This applies to boards of health, coroners, medical examiners, and medical experts. Such faulty and often vicious work defeats the purpose for which the law should have been made, drives good men from undertaking this class of work, and disgusts everybody.

Nor does the fault lie with those who are professedly politicians, but rather with the medical profession that backs up incompetent applicants; with medical schools that permit wholly unfit underlings to get a mere existence out of the State that they may serve the school for next to nothing while they hope for promotion, and with lawyers who are always ready to buy and use what no high-class man will furnish, that is, false testimony.

As a result, one finds the conditions for this sort of work most unsatisfactory, and far too little tendency to correct the evils on the part of those who should help.

All makers of postmortems are under the direct obligation to the department of registration of vital statistics of the State in which they operate to furnish a clear account from which a true cause of death can be recorded.

Persons devoting themselves to the narrow fields of special pathologic study often fail to comprehend their duties in these matters.

I have read hundreds of records of autopsies where it was all too evident that such a conception of duty had not been arrived at by the person who made the examination and dictated the notes.

I have often found it necessary to call up the operator and literally drag from him an account of the findings on which to found a legal cause of death, because he had thought that a list of the pathologic findings with little or no fixation of values attached was all that was necessary, and the question whether such findings had directly contributed to the death was only vaguely considered.

The tendency of the examiner to allow the clinician to arrive at a conclusion as to the cause of death and issue the certificate is strangely common in certain hospitals, where the pathologist has no scruple, about regarding his own findings as final and indulging in criticism of the mistakes of the clinicians, yet takes no steps to see that a correct certificate of the cause of death has been issued.

The subjects of classification of diseases and causes of death are considered in a subsequent section, as is also the special work of coroners and insurance examinations.

Civil medicine includes all examinations made with a view to clear up the matter of responsibility for damage done. The medical side deals with the determination of the damage and its effects on the person or of the body examined, and includes a proper estimate of the previous condition of that person before said damage was done; the nature of the damage, its extent, the sequelæ, and the significance each factor has to the findings as a whole.

While the responsibility for damage is not a part of the problem of the medical man, in ordinary cases anything found during the postmortem, or the investigation that should be made, which clearly shows such responsibility, is to be duly noted. Thus, alcoholism, brain disease, or severe organic lesion which caused the dead person to act abnormally in any way is of the most vital importance, and is to be most carefully considered as part of the work of the investigator. The vast field of industrial medicine is rapidly opening up, so that the many questions of damage resulting from occupation brings up the whole subject of poisons and wounds, which are discussed in separate sections.

This field has been but poorly treated of in works on pathology, and much of the detail in former sections was written with the difficulties of this particular field well in mind, so that every part of this work bears directly on this class of cases.

In this class of work one must understand the conditions under which the damage was inflicted, and this implies a more or less careful study of the industries or trades or occupations. Thus, elevator injuries differ from railroad accidents, and the poisons incident to occupations differ widely from those found in criminal or therapeutic poisonings. Even the infections are peculiar, for one seldom sees anthrax except in those who work about certain animal products, such as hair or hides,

and many infections have occupational relations that are more or less marked. Acquired tolerance plays a very important part in many industries. This is specially noticeable in the carbon poisons, CO, CN, C_6H_6, etc. On the other hand, chronic conditions result from the accumulation of poisons or their effects which may greatly change the nature of the tissues so as to modify their normal resistance, predispose toward certain types of disease, or produce obscure tendencies which change the picture presented when other disorders are superimposed.

Criminal medicine, or what has usually been called legal medicine, has largely to do with medical evidence of crime. Here the examiner has not only to determine whether damage was inflicted on the person, and the amount and sort and effects of such damage when found to have been received, but it becomes important to arrive at definite conclusions as to when and how such damage was inflicted.

The element of purpose is often most important. Thus, in a wound that was undoubtedly a fatal one, we are confronted with three possible explanations: (*a*) accident, (*b*) suicide, (*c*) homicide, and it is well within the province of the examiner to form definite conclusions on proper grounds regarding these matters.

This class of work is difficult, and requires special fitness and preparation along more or less definite lines. One must avoid shirking responsibility on the one hand, and undue assurance or eagerness to display smartness on the other.

Heretofore we have been chiefly interested with conditions and relations existing in the body, but the problems of criminal medicine are largely those of the relation of the body to some external object. A wound or hurt in the body has to be studied from a different point of view in such cases, or, rather, it has to be studied as before with another consideration added. The nature of the wound may be the same, even to details, in either of the three classes, but some little feature in the surroundings may show to which class it belongs. Often the position of the injury quickly settles the whole matter.

Generally such cases present the problem of deciding between one or other of two types, as between accident and homicide, or homicide and suicide.

One must study the sort of damage done in such a way as to be able to draw conclusions regarding the force applied, in all its elements of mass, momentum, direction, and duration, and the instrument used, and if an instrument is presented which is supposed to have been used one need not fall into the error of trying to confirm the judgment of less skilled persons who present all sorts of absurd theories.

In one famous case I had eight different weapons shown to me as having caused the wounds, brought by enthusiastic investigators, yet none of these weapons could be associated with the important wounds. I subsequently found other weapons, skilfully secreted in unusual places, which had been overlooked, and these fitted the wounds. While the medical evidence should be as complete by itself as possible, one often finds conditions that need explanation which no amount of care in the

examination can possibly clear up. One case I shall not easily forget, when I was subjected to great ridicule by the police authorities because I demanded an explanation of marks about the throat of a poor little asthmatic woman who had been found dead in a yard. The marks were very slight, but of a nature that aroused suspicion, and later on the murderer was found and convicted.

Nor can one wholly rely on the history presented to help one interpret the findings. I have some saturated solution of cyanid of potash from a case where three physicians were more than ready to sign the certificate of death from various natural causes.

The grave responsibility of these cases makes it important that the utmost skill and care be exercised in making the observations and in drawing conclusions, for an error which leads to the conviction and execution of an innocent person is nothing less than murder, and if one allows himself to be lead astray by importunate lawyers who desire to make out a nice case the responsibility still remains, though the criminality is shared by such lawyers. On the other hand is the neglect to accurately present true findings which would convict a vicious criminal. The person who indulges in such negligence is morally guilty of covering the crime, and in so far becomes a party to the crime after the fact. No one should undertake this class of work without such a sense of the importance and seriousness of it as will ensure high effort, nor should one attempt to assume expertness in this field without good reason in careful preparation for the task.

The medicolegal examination differs from the scientific one largely in point of view. Both require careful and complete following out of the peculiar problems involved in the case; neither will be the better for masses of irrelevant details. I am firmly convinced that it is far better to be clear and concise as to the essential matters, and to give the answers to the problems, rather than to present to a lot of more or less uninformed laymen the whole story of the investigation, because they do not know what it all means, and if they do not ignore it they are more likely to pick out bits which catch their fancy rather than the important things. I am supposing the operator is able to solve the problems; if he is not competent for the work he must hide behind a voluminous protocol. If he is not rightly sure of his answers to the problems he has no business to pretend that he is, and it need hardly be said that pretence or make believe savors strongly of perjury. A commonly printed error regarding the difference of such examinations is that the medicolegal one is more thorough and elaborate. This is far from true, for the scientist has a vast number of problems before him, while the medicolegal expert has but a limited number. The elaborateness of such an examination should depend on the conditions of the particular case.

In my early medicolegal work I spent much time and energy studying all the details of every problem because I did not know and could not find enlightenment in the literature regarding many things that were essential for a proper solution of the problems, but when I had mastered such fundamental matters it was not necessary to endlessly

repeat this labor. For the beginner the work must be as tedious and painful as the learning of any art, but the art will never be acquired by simply following a routine schema.

Perhaps the most important part in the solution of any problem is the clear statement of that problem, and next is the selection of the appropriate method to apply, and after a solution has been reached it must be tested out by a review of the steps and stages and a careful checking up of results. If one is handicapped by any reason, either from bad technic, weak eyes, shaky hand, or a slow mind, he must endeavor by all possible means to overcome these, but must always so adjust himself that none of these deficiencies shall by any possibility affect the final result. The man who is handicapped by narrow specialization must not allow his onesidedness to interfere with his task, and must recognize his personal equation, and not attempt to solve problems by the methods of his limited acquirements when they are not the right ones to use.

CAUSE OF DEATH

Systems of classification of causes of death have often been devised, and these have changed with the progress of medicine. A system will at best represent the conception, in the mind of its maker, of the philosophy of disease at the time it is made. Systems that seek to be final tend to impose imperfection on the philosophy, and to hold medical thought back by fastening it to the particular period in which the system was formed. Changes in classification render the massing of statistics difficult if not impossible.

For instance, Philadelphia had for many years a good practical system, but this was ordered changed to suit the recently adopted International Classification. The old system was discontinued, and it is no longer possible to connect the former series with the present one. This is a real loss, perhaps not fully appreciated by those who did not understand the value and wisdom embodied in the old system. The question which now remains is, How long will it be before a new system will be brought out to again destroy the continuity?

It is our duty to accept the system adopted, but to supplement it in a rational way, so that when changes are made, as they must be in the near future, there will be continuity of records.

It is our duty to conform with the International System, and it should, therefore, be taught in all schools of medicine and be understood by all who make certificates of death.

We should remember that a lot of clerks cannot be expected to follow all the vagaries of opinion of all the physicians of the nation. The physicians should, and experts must yield somewhat to the necessities of this work. The man who devotes more time in making out a perfectly acceptable certificate than he does to the understanding of the case is too insignificant to deserve attention, but, unfortunately, the type will grow if the system is too strongly advocated. We must

encourage a reasonable yielding to the system, but discourage subservience to it.

In the majority of cases there should be no difficulty at all, but many cases will not fit the system. At times only a lengthy description will adequately characterize the cause of death, and not a few cases present themselves where several causes share so nearly equally that it is not possible to say which is the primary and which is the contributing factor. Often one finds a series of conditions: for instance, a man dies of hemorrhage of the lungs, he has advanced tuberculosis; several weeks before death he took a dose of atropin, which, acting on bad kidneys, produced suppression of urine and increased blood-pressure; we are compelled to select a cause and a contributing cause in such a case. A hard drinker is injured seriously, later he develops delirium, then nephritis and uremia, and edema of the lungs with heart exhaustion. Shall we select the manner of his death, or shall we strive to determine a common-sense verdict that will do for practical purposes? To do this we must often make sharp, clear statements about vague and complex findings.

Again, we may be called to study cases where from postmortem change it is impossible to be certain as to the cause, and we are at times at a loss to determine even the manner of death. It is better to say "found dead" in such cases than to pick out some diseased organ and blame that. I am at times compelled to say what the probable cause is, but such an expression does not pass into the statistics. Our very limited knowledge of the true causes in many diseases makes it necessary at times to select the manner of death.

To say "asphyxia" is at times to say "respiratory failure." To say "congestion of the lungs" is not definite in half the cases one meets, while it is a true cause many times. Edema of the membranes of the brain may be a disease or an effect. Myocarditis is accepted, but in the great mass of cases I see it is a result of some more or less remote cause, and it is saying nothing more or less than "heart failure" in a different way, yet everyone knows that to say heart failure would create no end of trouble.

It is far too common for persons making postmortems to avoid finding the cause of death and attributing their neglect to some innate mystery in the case. I am not satisfied to claim that greatness of mind that overfrankly admits failure to find the cause of death after a postmortem.

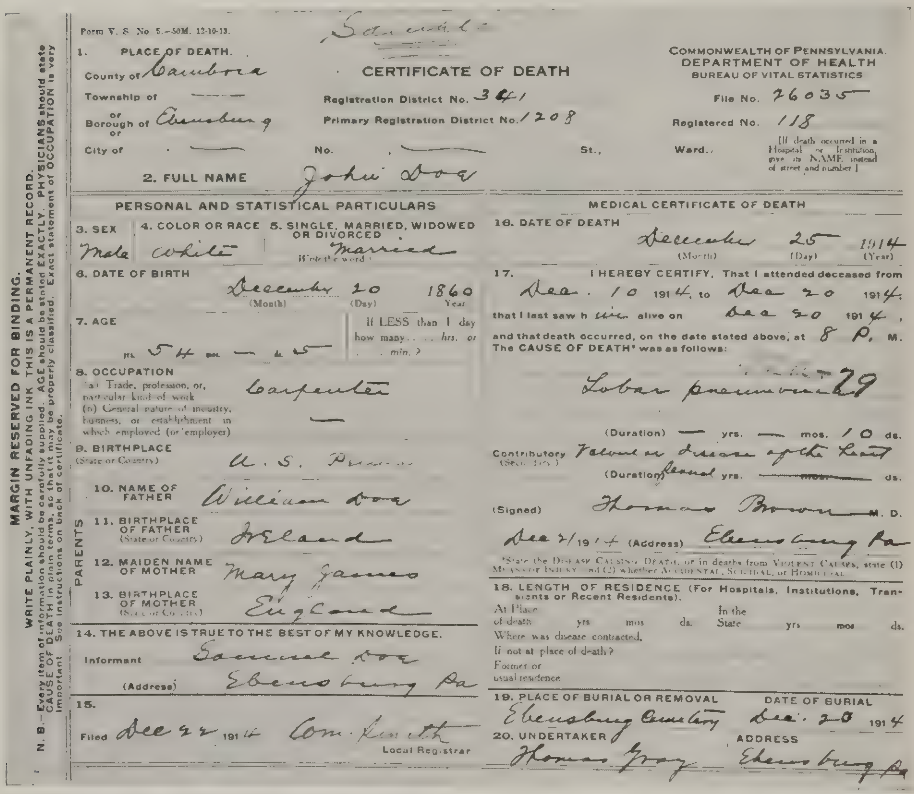
I want to have very definite and positive excuse for such greatness and frankness, and I find that the habit of asking myself Why don't you know? Why haven't you found the cause? has greatly reduced the temptation to invoke the mystery of the unknown. Every time when I have finished with what interests me or I happen to be weary or lazy this habit helps me. We hear far too much of failure to find the cause at the postmortem. Most of it is due to lack of persistence and competence, and the habit, once formed, tends to ruin a man and his work.

I see this in my work at the hospitals, where residents and chiefs

drift in and out, and later tell how the cause was not found, simply because they failed to see what was before their eyes, and in spite of the fact that the cause was very evident.

In court one is not so restricted as in a death certificate, but the difficulties of properly presenting the matter are by no means small.

Suppose a man having tuberculosis, bad kidneys, and some digestive disorders is shot in the leg; following this is a mild infection, which gradually yields and is healing, but not before the heart is seriously



MARGIN RESERVED FOR BINDING.

WRITE PLAINLY, WITH UNFADING INK. THIS IS A PERMANENT RECORD.

N. B.—Every item of information should be carefully supplied. AGE should be stated EXACTLY. PHYSICIANS should state CAUSE OF DEATH in plain terms, so that it may be properly classified. Exact statement of OCCUPATION is very important. See instructions on back of certificate.

Form V. S. No 5.—50M. 12-10-13.

COMMONWEALTH OF PENNSYLVANIA.
DEPARTMENT OF HEALTH
BUREAU OF VITAL STATISTICS

CERTIFICATE OF DEATH

1. PLACE OF DEATH.
County of Cambria
Township of ——
or Borough of Ebensburg
or City of —— No. —— St., Ward..

Registration District No. 341
Primary Registration District No. 1208
File No. 76035
Registered No. 118
[If death occurred in a Hospital or Institution, give its NAME instead of street and number.]

2. FULL NAME John Doe

PERSONAL AND STATISTICAL PARTICULARS

3. SEX Male
4. COLOR OR RACE White
5. SINGLE, MARRIED, WIDOWED OR DIVORCED (Write the word) Married
6. DATE OF BIRTH December (Month) 20 (Day) 1860 (Year)
7. AGE yrs. 54 mos. — ds. 5
If LESS than 1 day how many . . . hrs. or . . . min.?
8. OCCUPATION
(a) Trade, profession, or, particular kind of work Carpenter
(b) General nature of industry, business, or establishment in which employed (or employer) —
9. BIRTHPLACE (State or Country) U. S. Penna.

PARENTS
10. NAME OF FATHER William Doe
11. BIRTHPLACE OF FATHER (State or Country) Ireland
12. MAIDEN NAME OF MOTHER Mary James
13. BIRTHPLACE OF MOTHER (State or Country) England

14. THE ABOVE IS TRUE TO THE BEST OF MY KNOWLEDGE.
Informant Samuel Doe
(Address) Ebensburg Pa

15.
Filed Dec 22 1914 Com. Smith Local Registrar

MEDICAL CERTIFICATE OF DEATH

16. DATE OF DEATH December (Month) 25 (Day) 1914 (Year)

17. I HEREBY CERTIFY, That I attended deceased from Dec. 10 1914, to Dec 20 1914, that I last saw h im alive on Dec 20 1914, and that death occurred, on the date stated above, at 8 P. M.
The CAUSE OF DEATH* was as follows:

Lobar pneumonia 79

(Duration) — yrs. — mos. 10 ds.

Contributory (Secondary) Valvular disease of the heart
(Duration) Several yrs. —— mos. —— ds.

(Signed) Thomas Brown M. D.
Dec 21/1914 (Address) Ebensburg Pa

*State the DISEASE CAUSING DEATH, or in deaths from VIOLENT CAUSES, state (1) MEANS OF INJURY and (2) whether ACCIDENTAL, SUICIDAL, or HOMICIDAL.

18. LENGTH OF RESIDENCE (For Hospitals, Institutions, Transients or Recent Residents).
At Place of death yrs mos ds. In the State yrs mos ds.
Where was disease contracted,
If not at place of death?
Former or usual residence

19. PLACE OF BURIAL OR REMOVAL Ebensburg Cemetery
DATE OF BURIAL Dec. 20 1914

20. UNDERTAKER Thomas Gray
ADDRESS Ebensburg Pa

Fig. 258.—This is a sample certificate of death filled out for me by Dr. Elmer Batt, State Registrar of Vital Statistics for Pennsylvania, whose work in this line is well worth study. From this slip, which is the permanent record, the card shown in Fig. 259 is prepared. Note the figures above the cause of death: 92*a* indicates the number given lobar pneumonia, and is in blue pencil; 79 indicates the contributing cause, and is in red pencil.

affected by the sepsis. Add to these the following facts: The man drank to excess, was, in fact, drunk when shot, and was taking mercury and iodids and had an obstructing stricture of the urethra—this was an actual case. The death certificate read "homicide." In court I stated that the man died as the result of sepsis following a gunshot wound of

the leg, and that he had been suffering with a number of ailments which influenced his resistance to a wound not necessarily fatal, but serious and under the conditions fatal. The noble-hearted jury freed the man who did the shooting of all blame, but that was not my fault. The man had intended to inflict serious damage and was guilty of voluntary manslaughter.

In determining the cause of death the history of the case is often of as much value as the findings at the postmortem. This history must be trustworthy, but may be obtained from lay persons in cases of sudden death, and even at other times such accounts are most valuable.

The incompleteness of clinical histories, often through entirely excusable reasons, makes it necessary while using such records to do so

FIG. 259.—THIS CARD IS A COPY OF THE DEATH CERTIFICATE.

The holes are punched by means of a keyboard. Reading from the left by columns: 1. 1208, Primary Registr. Distr. 2. Gr. 8 = town of eighth class. 3. Year 19—. 4. 12 m(onth). 5. Sx, male. 6. Color, white. 7. Sc. (Social condition), m(arried). 8. Age: 44 yrs., 0 mos., 0 days. 9. Occ(upation), 6.07 (arbitrary number for carpenter). 10. N(ativity), U. S. 11. N. F. (nativity of father), Ir(eland). 12. N. M. (nativity of mother), OT(her). 13. Cs. (cause of death), 92*a*. 14. Con. Cs. (contributing cause), 79. 15. Pd. (place of death), HM. (Home). 16. R(esident). 17. Ad(ditional information). 18. (File number), 26035. These cards are $7\frac{3}{8}$ by $3\frac{1}{4}$ inches, are made in accordance with the Hollerith system, and can be counted, sorted, and tabulated by machinery. The cards are made in different colors for each class of records. The death record cards are deep rose color, which accounts for the dulness of the picture.

with great caution, but this is no reason for neglecting to study and fully use what is obtainable.

The immediate cause of death is of necessity due to some effect produced in one of the groups of organs on which life immediately depends. Life is extinct when the nervous centers are destroyed; death occurs almost immediately after the heart has stopped; life ceases within a few minutes after the lungs fail to perform their function; death surely but less quickly follows serious kidney failure.

The question here arises whether death is due immediately to either the lungs or kidney or to some influence on the nervous system or heart. My own experience clearly indicates that instant death only occurs in cases of nerve lesions, but that sudden deaths may be due to many causes.

Sudden death is a term which is generally rather loosely applied to what might be called unexpected death, but the term has become so commonly accepted that it is to be accepted and retained as a general classification, but not misunderstood. Any death which is quick or rapid may be considered as a sudden death if it was not or should not have been foreseen.

We must remember that death is a nervous phenomenon, and that it will quickly follow any great chemical or mechanical disturbance. Such chemical disturbances occur a few minutes after the heart or lungs stop; when the kidneys stop the chemical effect may be first on the heart or nervous centers. In any toxic condition the heart may be the mediate cause which precedes the death by a few moments.

Toxic conditions sufficient to set up nervous or myocardial changes may start in any of a number of organs, or may come from septic or extrinsic poisons.

It is far better to consider the source of such disturbances as the cause of death and the heart effect as an incident, though such a course would greatly reduce the number of deaths attributed to heart disease. Such a method, however, is full of difficulty, as we soon realize when we come to analyze the causes of heart disease, so that we are compelled to attribute many deaths to heart disease when we know that the heart was only the mediate cause. Thus, it is seen to be a necessary concession to convenience rather than scientifically accurate to classify certain cases as myocarditis, and the real cause of the condition must then be put down as contributing.

The most frequent contributing causes to myocarditis are gastro-intestinal and kidney conditions, infection, and anemia from whatever source.

The less frequent but by no means rare contributing causes are internal or endogenous poisons from disordered organs, such as the liver, spleen, and other internal glands, and rarely actual exogenous poisons.

Sudden death in children is very often due to respiratory exhaustion where the mechanism gives out under the sudden strain thrown on it by the sudden demand which begins at birth. A study of the manner of breathing of young children is most instructive in this connection, and should teach us something of the irregularity which accompanies this recently assumed function, and the histories obtained from mothers prove that exhaustion does often occur.

Many children have an added element of obstruction, either mucus in the air-passages, tight clothing or bandages, or a distended belly. These act as serious handicaps on the already struggling respiratory apparatus. Most young children that die suddenly show asphyxia. Toxemia from the gastro-intestinal canal and infections play an important part in disturbing the respiratory mechanism.

In adults the heart is the most generally affected or mediate cause of sudden death, but in children the heart has been thoroughly accustomed to its work before birth, and it is only rarely the mediate cause, the

respiratory apparatus being, in the great majority of cases, the sufferer. In this connection it will be remembered that the effect of asphyxia is relatively longer borne in the infant, and that the nervous centers are less dominant than in adult life, but the lower centers which are active suffer and cause death.

CORONER'S EXAMINATIONS

It matters little whether the official who inquires into sudden and suspicious deaths is called a coroner or a medical examiner or by any other name, the work which is to be done is much the same. The laws and regulations and customs vary somewhat in different States and towns as to the limits of such work, as well as to many details. It is, therefore, necessary for one undertaking to make examinations, either as coroner, coroner's physician, or medical examiner, to be sure what laws and rules he is to regulate his acts by.

It is well, if possible, to discover what rulings the local judges have made, for while it is unusual it is not unheard of for judges not fully occupied to make strange and peculiar rulings for reasons best known to themselves.

Having known of some of these wierd products myself, I deem this warning word quite desirable.

One judge ordered the coroner not to regard a human fetus unless it had attained an age when it was capable of independent existence in case an abortion was committed. The coroner would have been in contempt had he disregarded this truly remarkable ruling.

Another judge, in a period of mental perturbation, ruled that a coroner could not discharge a man when his investigation showed that death was due to accident. This ruling did not long remain in force, but it caused endless trouble for a time.

A very learned but excitable judge became very violent when he learned that a policeman, said to have beaten up a man two days before he died, had been discharged because I reported that the man had not been seriously hurt, but died of carbolic acid poisoning. The verdict of suicide by carbolic acid has not been changed and the judge subsequently recovered, and he has not interfered with the coroner's office since.

Generally coroners employ a physician to make examinations, but if the coroner is also a physician he may perform the posmortem himself. The difficulty that may arise in such a case is that he is a witness in his own court.

The order of the coroner is regarded as sufficient authority for the physician and absolves him from legal action. This question has been satisfactorily settled by courts of law. What responsibility attaches to the coroner for wrongly ordering a postmortem has only rarely been discussed in courts, but it has been ruled that he is not responsible for error of judgment unless there is evidence of malice or actual wrong-doing contrary to statute law. The plan to be adopted when the

authority vested in the physician by the order of the coroner is resisted by the family or friends of the deceased will largely depend upon conditions.

Infrequently one is in danger of serious violence. Once, when about to receive personal violence, I escaped by describing the pleasing effect that hanging would produce if the threats made were carried out. The effect was entirely satisfactory, the gentleman of brawn and liquor became very pale and very thirsty, and left me to finish my work.

At times wonderful religious scruples develop in most surprising places. Once, surrounded by a howling mob who were interested for financial reasons in falsely accusing a man of causing another's death and claiming that a postmortem was against their religion, I asked them what punishment their religious law prescribed for those who made false accusations. I was no longer annoyed.

Generally it is far better to use tact and kindness than to show authority; to explain rather than to use force, but where a serious crime has been committed it is always better to let the police clear the scene if they have not already done so before you arrive.

Where, however, a crime is suspected and the nature of the investigation demands secrecy, one must not arouse the fear of the suspected criminal by letting it be known you have any suspicions. In such cases the uniformed police had better be kept in the background and only discrete plain clothes men admitted, who will appear as assistants.

It is pleasanter to have bodies taken to a well-regulated morgue than to operate from house to house and in any unsuitable place, but there are cases where it is important to examine the surroundings. Sometimes this is absolutely necessary, at other times the feelings of the family would be outraged by having the body carted away from the home to a morgue. Both are perfectly good reasons for such practice. Where laws have been passed directing that the body shall be taken to the home if found in a public place rather than to the morgue, one has a right to have the body moved for cause. A very important factor is the effect on the body of unnecessary or incautious handling and transportation.

The physician who is to make the examination should receive not simply an order, but he should be given all the known facts and all the suspected conditions which will in any way assist him in the proper performance of his by no means easy task.

Too many examinations have been failures because the physician has neglected to obtain or those who are at work on the investigation failed to supply him with such information. Ignorance of what a postmortem is and should be is not confined to the medical profession, and one meets some truly remarkable ideas among the laity.

The examiner must cultivate what is called the judicial mind. He must review his own findings and the history without bias, favoritism, or theories.

A poor doctor always has a diagnosis ready before he has studied his case, and a detective generally has his theory, but the medical examiner

who combines the errors of both is a disgrace and a failure. Unfortunately, we do not train men at the medical schools in this country for medicolegal work, and the average graduate, unless he has by some accident of fate or personal bent been trained beyond the curriculum, has a very large proposition before him if he would fill creditably such a position. The available literature will assist him in at most 10 per cent. of his difficulties, and cause him confusion or error in an endless number of ways.

The work of the medical examiner is far broader than legal medicine, in which only the busiest examiners become proficient. Case after case of sudden death must be studied, analyzed, and recorded with only a few real court cases, and many of the cases that never reach court are more difficult than those which do.

The fundamental rules for a medical examiner are—

(1) Cultivate common sense, so that vagaries and fashions in medicine will not take precedence in the mind over fundamental principles.

(2) Master the whole case—history, rumor, findings—no matter how insignificant.

(3) Use simple language as far as possible, and you will think better and do vastly better work with the lay minds you meet.

(4) Forget the routine methods as soon as you can make a good examination.

(5) Cultivate a power of judging values and discriminate between essentials and trifles, avoiding lengthy descriptions of insignificant things, and the giving of equal place to great and small factors.

(6) Pay attention to lesions rather than organs where violence enters.

(7) Avoid pedantic display of knowledge of any one of the dozen subsidiary sciences, including anatomy, chemistry, physics, diagnosis, therapeutics, pathology, psychology, lest you develop the abominable habit of making a part of knowledge disproportionately and dominantly insistent.

(8) Do not cultivate too much fear or reverence for the members of an inferior profession, even though some have arrived at the standards long held up by your own. Pay respect where it is due, but never cringe to a court or lose dignity with lawyers.

The coroner or his physician, or both, will be called on to investigate all deaths where violence of any sort was a factor or was supposed to be a factor. This will be sure to include a vast range of accidents in public places, in homes, in factories, in public conveyances, at fires, on buildings, by gas and electricity; and one can readily realize that interests will often be at work which would interfere with a full investigation.

If one goes along quietly, honestly seeking the truth and fearlessly stating it when found, avoiding on one side improper favoritism, and on the other any unfairness, even the interests will be respectful.

The examination of the body in these cases is by no means all one

should do. One should be able to analyze the probabilities as to the manner of infliction of the injuries. Industrial poisonings are gradually coming into notice in this country, and it is no easy task to sift some of these cases thoroughly. Infections, such as tetanus, anthrax, and the contagious diseases, all bring one into close contact with the health authorities, and make it necessary to know exactly what regulations are in force regarding such cases.

The issuing of certificates embodying the verdict of the jury or the finding of the examiner makes it desirable that some one about the office should have a very clear notion about the standard of classification of

The attending physician must furnish a certificate in ordinary cases, within 24 hours after death; in contagious cases, within 12 hours.

If a person dies from **criminal violence,** or **by a casualty,** or **suddenly while in apparent health** or when unattended **by a physician,** or when a **registered physician has been in attendance for less than 24 hours,** or in any **suspicious or unusual manner** the case must be referred to the **Coroner.**

A stillbirth must be registered both as a birth and death, The date of death should be the date of delivery and the death certificate should further state, if known. the cause of the stillbirth and the period of utero gestation in months.

Statement of occupation.—Precise statement of occupation is very important, so that the relative healthfulness of various pursuits can be known. The question applies to each and every person, irrespective of age. For many occupations a single word or term on the first line will be sufficient, e. g., *Farmer, Physician, Stenographer, Compositor, Architect, Locomotive engineer, Civil engineer, Stationary firemen*, etc. But in many cases, especially in industrial employments, it is necessary to know (*a*) the kind of work and also (*b*) the nature of the business or industry, and therefore an additional line is provided for the latter statement; it should be used only when needed. As examples: *(a) Spinner, (b) Cotton mill; (a) Salesman, (b) Grocery; (a) Foreman, (b) Automobile factory.* The material worked on may form part of the second statement. Never return "Laborer," "Foreman," "Manager," "Dealer," etc., without more precise specification, as *Day laborer, Farm laborer, Laborer—Coal mine*, etc. Women at home, who are engaged in the duties of the household only (not paid *Housekeepers*, who receive a definite salary), may be entered as *Housewife, Housework*, or *At home*, and children, not gainfully employed, as *At school* or *At home*. If the occupation has been changed or given up on account of the DISEASE CAUSING DEATH, state occupation at beginning of illness. If retired from business, that fact may be indicated thus: *Farmer (retired, 6 yrs.)* For person who have no occupation whatever, write *None*.

Statement of cause of death.—Name, **first**, the DISEASE CAUSING DEATH (the primary affection with respect to time and causation), using always the same accepted term for the same disease. Examples *Cerebrospinal fever* (the only definite synonym is "Epidemic cerebrospinal meningitis"); *Diphtheria* (avoid use of "Croup"); *Typhoid fever* (never report "Typhoid pneumonia"); *Lobar pneumonia; Bronchopneumonia* ("Pneumonia," unqualified, is indefinite); *Tuberculosis* of *lungs, meninges, peritonaeum*, etc., *Carcinoma, Sarcoma*, etc., of............(name origin; "Cancer" is less definite; avoid use of "Tumor" for malignant neoplasms); *Measles; Whooping cough; Chronic valvular heart disease; Chronic interstitial nephritis*, etc. The contributory (secondary or intercurrent) affection need not be stated unless important. Example: *Measles* (disease causing death), *29 ds.; Bronchopneumonia* (secondary), *10 ds.* Never report mere symptoms or terminal conditions, such as "Asthenia," "Anaemia" (merely symptomatic), "Atrophy," "Collapse," "Coma," "Convulsions," "Debility, (Congenital," "Senile," etc.), "Dropsy," "Exhaustion," "Heart failure," "Haemorrhage," "Inanition," "Marasmus," "Old age," "Shock," "Uraemia," "Weakness," etc., when a definite disease can be ascertained as the cause. Always qualify as "PUERPERAL *septichaemia* " "PUERPERAL *peritonitis*," etc., all diseases resulting from childbirth or miscarriage. State cause for which surgical operation was undertaken. For VIOLENT DEATHS state MEANS OF INJURY and qualify as ACCIDENTAL, SUICIDAL, or HOMICIDAL, or as *probably* such, if impossible to determine definitely. Examples: *Accidental drowning; Struck by railway train—accident; Revolver wound of head—homicide; Poisoned by carbolic acid—probably suicide.* The nature of the injury, as fracture of skull, and consequences (e. g., *sepsis, tetanus*) may be stated under the head of "Contributory."

FIG. 260.

causes of death at the time in use in the State. Problems of identification of the dead are constantly coming up, and one must always be on guard against false identification.

Legal interests of almost infinite variety arise either about the dead, their property, inheritance, rights to bury or claim body, recovery of damages for injury to the deceased, matter of insurance of all types, questions of beneficial societies, religious bodies, fraternal orders, charities, government officials, foreign consuls, and, last of all, crime

and the whole machinery in force for apprehending, trying, and segregating criminals, including courts and hearings.

The examination of the body is not a thing apart from all these, and any conception based on a brainless system of rules will utterly fail in practice unless it is controlled by a larger point of view, a common-sense recognition of all the features, and an adjustment of the proceedings to fit the peculiarities of each case. The object of the examination is to throw light on the thing which should be investigated at the inquest. Any smaller view of the work is belittling, inadequate, and should not be tolerated.

MARGIN RESERVED FOR BINDING.

WRITE PLAINLY, WITH UNFADING INK - THIS IS A PERMANENT RECORD.

N. B.—Every item of information should be carefully supplied. AGE should be stated EXACTLY. PHYSICIANS should state CAUSE OF DEATH in plain terms, so that it may be properly classified. Exact statement of OCCUPATION is very important. See instructions on back of certificate.

Form V. S. No. 5.–C–12-8-09.

1. PLACE OF DEATH.

County of PHILADELPHIA,

Township of ....

or

Borough of ....

or

City of PHILADELPHIA. (No. .... St.; .... Ward.) [If death occurred in a Hospital or Institution, give its NAME instead of street and number.]

CERTIFICATE OF DEATH.

Registration District No. 1.

Primary Registration District ....

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF HEALTH
BUREAU OF VITAL STATISTICS.

File No. ....

Registered No. ....

2. FULL NAME ....

PERSONAL AND STATISTICAL PARTICULARS

3. SEX

4. COLOR OR RACE

5. SINGLE, MARRIED, WIDOWED OR DIVORCED (Write the word.)

6. DATE OF BIRTH .... (Month) .... (Day) ....1 (Year)

7. AGE .... yrs. .... mos. .... ds. If LESS than 1 day how many..........hrs. or ....min.?

8. OCCUPATION
(a) Trade, profession, or particular kind of work ....
(b) General nature of industry business, or establishment in which employed (or employer) ....

9. BIRTHPLACE (State or Country)

PARENTS

10. NAME OF FATHER

11. BIRTHPLACE OF FATHER (State or Country)

12. MAIDEN NAME OF MOTHER

13. BIRTHPLACE OF MOTHER (State or Country)

14. THE ABOVE IS TRUE TO THE BEST OF MY KNOWLEDGE.

(Informant) ....

(Address) ....

15.

Filed ....191.. .... Local Registrar

MEDICAL CERTIFICATE OF DEATH

16. DATE OF DEATH

.... (Month) .... (Day) 191.. (Year)

17. I HEREBY CERTIFY, That an Inquest was held upon the body of the above named deceased on the .... day of .... 191.. ; that the jury rendered a verdict giving the cause of death as follows:

....

(Signed) .... Coroner.

.... 19.. (Address) ....

*State the DISEASE CAUSING DEATH, or in deaths from VIOLENT CAUSES, state (1) MEANS OF INJURY, and (2) whether ACCIDENTAL, SUICIDAL, OR HOMICIDAL.

18. LENGTH OF RESIDENCE (FOR HOSPITALS, INSTITUTIONS, TRANSIENTS OR RECENT RESIDENTS).
At place of death..........yrs..........mos..........ds. In the State..........yrs..........mos..........ds.
Where was disease contracted, If not at place of death? ....
Former or usual residence .... Ward, ...

19. PLACE OF BURIAL OR REMOVAL | DATE OF BURIAL ....191..

20. UNDERTAKER | ADDRESS

FIG. 261.

CORONER'S RECORDS

The reverse side of the ordinary death certificate (Fig. 260) in use in the State of Pennsylvania shows when cases are to be referred to the coroner and how certificates are to be filled out. The face of the certificate to be filled out by coroners is seen in Fig. 261.

These certificates are filed with the local registrar, and copies are made, so that one file is in the city and another is with the State Registrar, where all the vital statistics are kept.

The coroner, however, has certain definite needs for records. For small towns these should be systematically made, filed, and indexed according to a more nearly uniform method throughout the country.

In large cities inquisition sheets are made out, and from these a docket duly indexed is kept, and stenographic reports are filed with all papers relating to the case.

In order to have the records complete and still keep a tally of the cases it was found desirable to adopt some form of check-up system for the thousands of cases investigated in the office of the coroner of Philadelphia.

The accompanying figures show the nature of these cases as displayed by the tally-sheet book which I devised several years ago.

Being unable to adopt the card system of indexing causes of death, and desiring to have statistics available for use from month to month, with an easy method of consolidating these into an annual report, the next best means was to be found. The problem I was presented with in planning such a book was to devise a grouping of causes of death that would be in keeping with the system adopted by the State Registrar of Vital Statistics, yet be easily used by available clerical workers, and would show something of the work of the office as well as furnish statistics as to the occurrence of sudden death and the principal groups of diseases in which such deaths occurred, as well as some side light on the relation of color, sex, and condition to the number of cases.

The whole scheme was then to be reduced to two pages of a book, so that the month's work would appear as a single sheet when the book was opened. Space had to be allowed for the probable number of tally marks under each heading, for the cases were to be entered at the close of the inquest each day. The left-hand page contained the diseases above (see Fig. 262), and abortions, homicides, and all ages below (see Fig. 265). The right-hand page contained all accidents (see Figs. 263, 264). The grouping of diseases has only the merit of being suited to the needs of coroners' offices. That of accidents is, I believe, an improvement on previous groupings.

It was found impossible to combine an age table to show the ages at which death occurred opposite each group of causes, and as such would not have been of special value all ages are tabulated together except homicides, suicides, abortions, and trolley accidents. I have used the actual pages of the report of Coroner Knight for 1913 because I think the figures are of value.

Of the other blanks needed for the work of the office we need not speak, except of notices to physicians to investigate cases and the official physicians' report blank. This blank has been used for many years and is, in general, satisfactory.

CAUSE OF DEATH
Diseases

Diseases	Color			Sex		Condition					Total
	White	Colored	Other	Male	Female	Single	Married	Wid.	Div.	?	
General Diseases											
Senility	38	2		14	26	7	15	18			40
Tumor	12	2		6	8	3	7	2		2	14
Infections—Epidemic	11	2		8	5	12	1				13
Sepsis	3	1		2	2	4					4
Tuberculosis	98	30		90	38	53	63	6		6	128
Other General	15	2		12	5	9	4	3		1	17
Nervous System											
Brain—Apoplexy	150	11		85	76	21	82	54	1	3	161
Other	13	1		7	7	3	10			1	14
Convulsions	11	1		8	4	12					12
Other Nervous System	17			12	5	6	8	2	1		17
Circulatory System											
Heart—Angina Pectoris	34	1		28	7	12	21	2			35
Dilatation	111	13		78	46	31	62	25		6	124
Endocarditis	16			9	7	6	7	3			16
Myocarditis	65	3		42	26	10	34	18	1	5	68
Pericarditis	9			5	4	4	1	1		3	9
Valvular	67	10	1	41	37	12	53	8	1	4	78
Other Heart Disease	320	37	1	204	154	61	201	72	1	23	358
Blood Vessels	22	3		13	12	2	14	9			25
Respiratory System											
Lungs—Asthma	3	1		3	1	1	2		1		4
Bronchitis	23	7		22	8	26	3	1			30
Congestion	6			4	2	5	1				6
Pneumonia	156	41	1	112	86	124	53	16		5	198
Other	44	7		39	12	25	16	7	1	2	51
Nose or Throat	4			3	1	4					4
Digestive System											
Mouth or Teeth	26	3		13	16	29					29
Stomach or Oesophagus	85	20		46	59	58	36	11			105
Stomach and Bowel	71	12		49	34	78	5				83
Bowel	32	3		23	12	27	5	3			35
Bowel Obstruction	15	3	1	13	6	15	3	1			19
Peritonitis	12			8	4	4	8				12
Liver	17			10	7	4	11	1		1	17
Other	7	2		8	1	2	6	1			9
Urinary System											
Kidney	191	18		116	93	64	90	44		11	209
Uremia	29			21	8	4	18	4	2	1	29
Diseases of Women	3	1			4		4				4
Child Bearing	38	1			39	1	37			1	39
Early Infancy—Accidents of Birth	6	2		5	3	8					8
(Under Three Months) Congenital defects	27	1		19	9	28					28
Convulsions	37	2		21	18	39					39
Malnutrition	36	4		26	14	40					40
Premature Birth	88	9		61	36	97					97
Still Born	35	7		22	20	42					42
Diseases of Bones or Joints		2		2		2					2
Surgical Conditions	7	2		7	2	7	1	1			9
Undetermined (Owing to Condition of Body)	12	2	1	12	3	10	4			1	15
Tetanus—Following Vaccination Due to Subsequent Infection	4			3	1	4					4
Totals	2026	269	5	1332	968	1016	886	313	9	76	2300

Fig. 262.—Consolidated Report for Year 1913, Coroner of Philadelphia. (See also Figs. 263–266.)

CAUSE OF DEATH
Accidents

Cause of Injury	Color			Sex		Condition					Where Rec'd.			Total
	White	Colored	Other	Male	Female	Single	Married	Wid.	Div.	?	At Home	At Work	In Public Place	
Hydrophobia	2			2		2					1		1	2
Asphyxia	18	4		14	8	20	2				21		1	22
Choking	10			7	3	6	3	1			10			10
Building Operations	2			2			2					2		2
Burns and Scalds—Bonfires	6	1		2	5	6	1						7	7
Conflagration	9			4	5	6	3				4	1	4	9
Hot Fluids	36	1		23	14	32	2	2		1	35	2		37
Lamps	5	1		2	4	3	3				6			6
Matches	36	2		17	21	38					38			38
Stove	33	7		6	34	32	7	1			39	1		40
Steam	2			1	1	1	1					2		2
Other	17			10	7	10	5	2			11	5	1	17
Cold.	3	1		4		4					1		3	4
Drowning—Boating.	7			6	1	6	1						7	7
Swimming	12	1	1	14		10	4						14	14
Other	65	4	3	69	3	34	19	2		17		3	69	72
Electricity	6	2		8		2	6					6	2	8
Explosion	7			6	1	2	5				1	6		7
Firearms	12			9	3	9	3				8		4	12
Gases—Coal	1			1			1				1			1
Fires	1				1		1				1			1
Illuminating	66			37	29	17	26	16	1	6	65		1	66
Other	1			1		1					1			1
Heat	46	3		28	21	26	23				33		16	49
Injuries—Blows	3			3		1	2				1	1	1	3
Crushes	7			7		3	4				1	3	3	7
Falls—Downstairs	92			50	42	16	48	26		2	87		5	92
On Street	48			39	9	15	22	8	1	2	2	7	39	48
Other	140	5		96	49	42	61	35	1	6	72	38	35	145
Falling Objects	21	3		22	2	10	12	1	1		1	15	8	24
Machinery—Breaking	6			6		2	4				1	5		6
Caught By	12			12		4	7	1				12		12
Caught By Belt	1	1		2			2					2		2
Faulty	2			2			2					2		2
Play	4			4		4					1		3	4
Other Wounding	5			4	1	1	4				4		1	5
Totals	744	36	4	520	264	365	286	95	4	34	446	113	225	784

CAUSE OF DEATH
Accidents

Transportation	Color			Sex		Condition									Total
	White	Colored	Other	Male	Female	Single	Married	Wid.	Div.	?	Passenger	Employee	Trespasser	Other	
Automobile	49	6		46	9	30	20	4		1	9	1		45	55
Bicycle	1			1		1					1				1
Elevator—crushed by	12			11	1	5	7					11		1	12
fall of	2			2		1				1		1		1	2
fall down shaft	11	3		14		8	6					12	1	1	14
Horse and wagon	65	3		57	11	40	22	4		2	20	2		46	68
Motorcycle	3			3		2	1				1			2	3
Railroad	74			72	2	34	31	3		6	1	31	27	15	74
at crossing	18	1		17	2	9	9	1				3		16	19
Trolley—surface	36	1		23	14	17	14	3		3	5	1	6	25	37
crossing	33	2		23	12	19	10	6			2	4	2	27	35
elevated	1			1						1				1	1
Vessels		1		1		1						1			1
	305	17		271	51	167	120	21	_	14	39	67	36	180	322

FIG. 263.

CAUSE OF DEATH
Accidents

Poisons	Color			Sex		Condition					Total
	White	Colored	Other	Male	Female	Single	Married	Wid.	Divorced	?	
Alcohol	2			2		1				1	2
Arsenious Acid	3			3		1	2				3
Bichloride mercury	3			2	1	2	1				3
Benzine	1			1		1					1
Carbolic Acid	8			7	1	5	2	1			8
Chronic lead	1			1		1					1
Corrosive sublimate	2			2		1	1				2
Cyanide potassium	2			2				2			2
Fumes sulphuric and cyanogen	1			1		1					1
Heroin	6			5	1	4	1	1			6
Hydrochloric	1			1		1					1
Mineral poisoning	1			1		1					1
Morphine	5			3	2	2	2		1		5
Opium	3			2	1	1	2				3
Paraldehyde	1			1			1				1
Phosphorus	3			3		3					3
Tartar emetic		1		1			1				1
Turpentine	1			1				1			1
	44	1		39	6	25	13	5	1	1	45

FIG. 264.—WITH FIG. 263 FORMS RIGHT-HAND PAGE OF MONTHLY REPORT BOOK.

ABORTIONS	COLOR			CONDITION					AGE			
	White	Colored	Other	Single	Married	Wid.	Div	?	Under 20	20-30	30-40	Over 40
Criminal												
Natural												
Self-performed												
Open verdict												

HOMICIDES	COLOR			SEX		CONDITION					TOTAL
	W	Col.	Other	M	F	S	M	W	D	?	
Asphyxia											
Blows											
Cutting and stabbing											
Drowning											
Gunshot											
Objects thrown											
Poison											
Other											

SUICIDES	COLOR			SEX			
	W	Col.	Other	M	F	S.	M.
Cutting							
Drowning							
Gunshot							
Hanging							
Jumping							
Poison—carbolic							
cyanide							
gas							
other							
Other							

AGES

	Fœtus	Under 1 year	1-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
Homicides										
Suicides										
Trolley										
Total										

FIG. 265.—WITH FIG. 262 CONSTITUTES LEFT-HAND PAGE OF MONTHLY REPORT BOOK. This cut is made directly from part of an unused page (the whole page is 19 by 24 inches), and shows spacing calculated for by study of the records of the previous ten years.

REPORT OF AUTOPSY.

Philadelphia, ... 19

Name ....

Age .... Sex .... Color .... { Married / Single

Residence .... Date of Death ....

Place of Death ....

Post Mortem at .... Date 19

Identification ....

....

EXTERNAL EXAMINATION

Height .... Weight ....

MARKS:

- Head ....
- Body ....
- Limbs ....

Remarks: ....

INTERNAL EXAMINATION

I. Brain ....

II. Lungs ....

III. Heart ....

IV. Liver ....

V. Stomach ....

VI. Kidneys ....

VII. Intestines ....

VIII. Bladder ....

IX. Uterus ....

Remarks: ....

Cause of Death ....

.... *M. D.*

FIG. 266.—REPORT OF AUTOPSY BLANK USED BY CORONER'S OFFICE OF PHILADELPHIA. Size 8 by 12 inches' found to be practical.

For my own personal use, however, I have several forms of cards which I find useful:

(*a*) A general index and synopsis card (Fig. 267).

(*b*) A gunshot wound synopsis (Fig. 268).

(*c*) For all other forms of violence (Fig. 269).

(*d*) Poisons: outline of case and findings (Figs. 270, 271).

These, with the records already described under Notes, constitute a good working system.

POST MORTEM — CAUSE OF DEATH — DATE OF

No. 4598 — Still born — 4/9/14

COMPLICATIONS —

AGE full term SEX F CONDITION S- RACE Col. DIED 4/4

EXTERIOR Cord torn off close to body

CAVITIES

P. Sec.		P. Sec.	
HEART	—	SKIN	—
BLOOD	dark as in asphyxia	MUSCLES	—
LUNGS	contain no air	BONES	—
LIVER	congested	GLANDS	—
PANCREAS	—	..	
SPLEEN	—	..	
STOMACH	nearly empty	BLOOD VES.	—
INTESTINES	full of meconium	SEX ORGANS	—
KIDNEY	—	BRAIN	—
BLADDER	—		

See plates - dissection of child

Child abandoned in street

ATROPHY — HYPERTROPHY + CHRONIC C ACUTE A. DEGREE I-V NEG. O. DISTENDED D.

FIG. 267.—GENERAL INDEX CARD—ASSORTED AND FILED UNDER CAUSES OF DEATH.

Note space on either side of the list of organs to record degrees of involvement: in the left space primary lesions, in the right space secondary lesions, are recorded. In the blank space, nature of lesion, and below, explanatory notes. The case was one of a practically normal child. The cause of the still-birth was not ascertained. The photographs in Series I, Dissection of Child, were of this case. The cards are of good quality, $4\frac{1}{4}$ by 6 inches, and are a great convenience for quickly referring to types of cases. While less satisfactory than the Hollerith cards for compiling statistics, they are better suited for analysis because nature and degree can be combined with conditions noted.

GUN SHOT WOUNDS

CASE NUMBER 4594 DATE 3/30/14 CLASS accident

AGE 10 SEX m. COND. S. RACE Polish

WOUND OF ENTRANCE front of mouth

COURSE nearly straight back

2 lower left incisors out

ORGANS Tongue, pharynx - spine

LOCATED 3rd cervical vertebra

SEQUELAE Infection of tissues about spine

general sepsis - died in 14 days

TRIAL Inquest 4/3/14 - verdict. accident

No. 4603 VIOLENCE TYPE

Haemorrhage of brain Accident

AGE 46 SEX M COND. RACE Irish DATE 4/14/14

DIED AT P. G. Hospital " 4/13

RECEIVED 3rd & Spring Garden Sts. " 4/11

HOW fall on street

EXTENT fracture right orbit and frontal bone

(see plates)

SEQUELAE haemorrhage into lids - and about brain

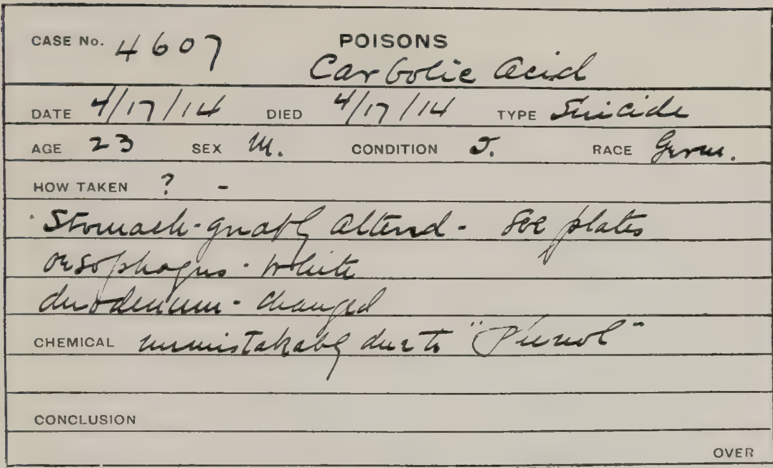
Contra Coup. in posterior base slight

but few haemorrhage under cerebellum

TRIAL Inquest 4/21/14

FIGS. 268, 269.—WHERE GREATER DETAIL OF PARTICULAR SORTS OF CASES IS REQUIRED.

For gunshot wounds it is sufficient for a clear, quick grasp of the case.
On the back of the card is placed the description of the bullet in detail.
A similar card is seen below for cases of violence.
These index cards are 3 by 5 inches.



CASE No. 4607 POISONS Carbolic acid

DATE 4/17/14 DIED 4/17/14 TYPE Suicide

AGE 23 SEX M. CONDITION J. RACE Germ.

HOW TAKEN ? -

Stomach-greatly altered - See plates

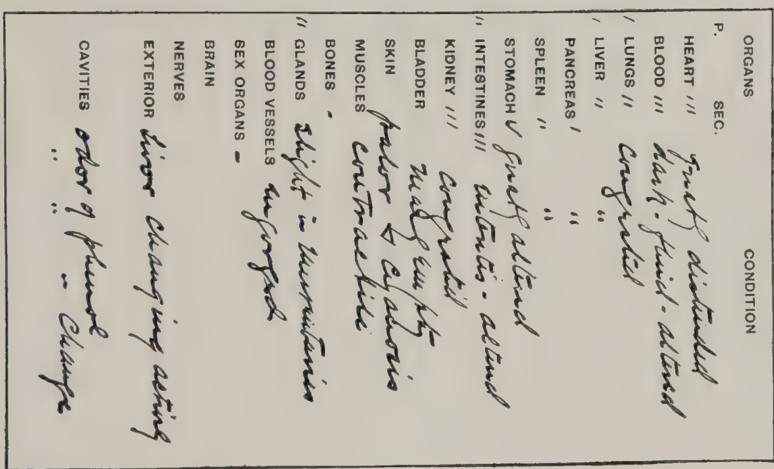
Oesophagus - white

duodenum - changed

CHEMICAL unmistakable due to "Phenol"

CONCLUSION

OVER



ORGANS	CONDITION
P. SEC.	
HEART ///	greatly distended
BLOOD ///	dark - fluid - altered
/ LUNGS //	congested
/ LIVER //	"
PANCREAS /	"
SPLEEN //	"
STOMACH ✓	greatly altered
// INTESTINES ///	enteritis - altered
KIDNEY ///	congested
BLADDER	well filled
SKIN	pallor & cyanosis
MUSCLES	contractile
BONES	-
// GLANDS	slight in mesenteric
BLOOD VESSELS	engorged
SEX ORGANS	-
BRAIN	
NERVES	
EXTERIOR	livor changing ashing
CAVITIES	odor of phenol
	" " - change

FIGS. 270 AND 271.

FIG. 270.—Poison index card with simple analysis of findings.
FIG. 271.—The reverse side of the card, with a brief résumé of the findings in the organs.

Note // before intestines, which means enteritis existing before ingestion of poison, while ///, on the right, represents the degree of the changes produced by the poison. A photograph of the stomach from this case is seen in Fig. 204.

MEDICAL EVIDENCE

FEW topics have been more abused. Every physician who has been called to the witness-stand has definite notions about the subject, and every lawyer who has heard a few doctors testify knows all about how it should be done. Text-books and periodicals are full of platitudes about medical testimony.

The man who is sincere in his work and is competent to give good testimony not infrequently fails because he does not know just what to do nor where to turn for help in preparing for what he regards as an ordeal. My own experience of sixteen years in the courts has taught me much that I do not find in the books, and had it been accessible in the first years of my work would have have been most acceptable and useful. The problems of medical evidence may be grouped into two topics—(*a*) gathering and (*b*) presenting.

Gathering evidence is an art which few can practice successfully without care and training, and some have greater difficulties to overcome than others. The patience and persistence that mark the good collector are always valuable assets, but they are but the beginning. An appreciation of the nature of evidence and a grasp of the difference between good and bad evidence and a moral code are essential. The amount of bad evidence is astounding, and yet what is called bad evidence is not always bad, and not infrequently what is called good evidence is entirely bad.

Good evidence rests on a realization of the nature of evidence. Evidence is so much of observed facts as can be properly used by common sense or judgment to draw conclusions from regarding some particular question. Irrelevant facts have no part in evidence. Evidence of malaria is different from evidence of a burn, and the man who investigates all cases according to a formula accumulates not evidence, but data, most of which is worthless. Data may or may not be evidence of anything, and if gathered thoughtlessly often mislead those who seek for enlightenment.

The diagnostician who accumulates enormous masses of data without realizing (that is, estimating) the values of the parts seldom does creditable work. The man who makes endless accurate measurements of lesions frequently fails to arrive at a real understanding of the lesion, which is the vital thing. Take Virchow's Second Model Protocol, which is full of data which took several hours to collect, and yet the gunshot wound is not even tolerably described, and that was the crux of the whole case.

Evidence presupposes an object or purpose which must be kept in mind throughout the investigation, and this is not to be confused with

any improper striving to maintain a theory. The evidence of a disease is sought for in an orderly manner and with a definite purpose, but no just and right-thinking person will allow himself to be carried away by a theory. If the evidence which he seeks is not there, he honestly says so.

All science is based on evidence, and there is no fundamental difference between the nature of the evidence which underlies belief in good laboratories or clinics, in good law courts, or in any walk of life. The trifler who spends his time and energies over irrelevant matters is a common spectacle in all walks of life. He gets evidence, but it is of little value, and he leaves ungathered the essentials. He hastens to dig the bullet from the wall, but fails to note the direction in which it pointed. He notes the strange nervous symptoms of a patient and ignores the fact that there is extensive infection eating its way along the nerve paths. He hears of a trolley accident, and finds brain symptoms and lets the patient die of an abscess of the throat. He finds a dog bite and he sees convulsive action about the throat, and he has evidence from which he diagnoses hydrophobia, while the patient is expiring from pneumonia and the convulsions are but exaggerated respiratory efforts.

Evidence must be sorted and arranged even while it is being gathered.

It cannot be gotten automatically, but requires real thinking, and such thinking presupposes special knowledge and the ability to think rightly. There is nothing strange or new to a well-trained medical man about evidence for a law court.

The evidence of an injury to the great occipital nerve is the same, whether it is to be presented to a body of medical experts for scientific discussion or to a court of law in a damage suit.

Perhaps the average medical man is not sufficiently trained in self-criticism or in modern scientific methods of observation and thinking, and if this is so, that average man will find his failures very hard to defend from the witness-stand if he has able opponents.

False evidence results very commonly in disaster, because the old legal phrase—the truth, the whole truth, and nothing but the truth—has been wholly or partly forgotten.

How often do I see this exemplified in my work at the postmortem table. Most doctors tell me the truth and nothing but the truth, but few tell me the whole truth, because they have gathered evidence not wisely but too well. They have seen a few things and have ignored the values of these while they were seeing them. Truth consists very largely of judgment, for it is just as much a matter of judgment to say that an object is round or brown or heavy as it is to say that a kidney is congested or atrophied or that a lung is edematous. Observation and judgment are so inextricably united that it is only by the greatest care in self-analysis that we realize how much of what we call observation is really judgment and estimate, and it is only by constant care that we can keep those judgments and the resulting "observations" true.

Evidence gathering requires a recognition of the "personal equation" far more than is generally appreciated. No astronomer would take delicate observations without a knowledge of his tendency to make certain errors, nor would a chemist think of using reagents not previously tested, but many medical men fail to realize this principle of personal equation.

I know an eminent opthalmologist who tested himself every morning before he began work, and he would not operate if he was unable to perform certain delicate tests, but such examples are rare, and the ordinary results are like the experience of the color-blind portrait painter of Boston who had his palette prepared for him; but one day he mixed his own palette and painted a portrait in green instead of red.

Evidence always bears the mark of the personality of the person who gathers it just as truly as does the honey smell of the bee. No more vital or fundamental matter can be found in the whole realm of evidence than this personal factor, and no more important foreword can be given to those who would become evidence collectors than that they give it most constant and careful consideration.

After the evidence has been accumulated it is necessary that it should be preserved, and the matter of records is of great importance. The human mind is the natural repository for impressions and memories, but it is common knowledge that the human mind is a great place where are many things, and not a few things get misplaced in it and are temporarily, at least, lost and cannot always be found. It is necessary to have such a system of keeping records as will bring to mind quickly the pictures formed by observation and thinking. The courts recognize this and allow the use of records to refresh the memory. It is not necessary to make flowery protocols; in fact, it is a foolish and altogether bad policy to bury the essentials in a mass of data, because they do not serve the only purpose for which they are made.

Having, then, obtained evidence and made suitable notes, we are ready for the call of court or scientific meeting or discussion.

The presentation of evidence before a court is called testimony, and this differs from other methods of relating experience in many ways. There is an element of art in doing everything, and there is a large element of art in testifying in courts, but it is not necessarily a very high or fine art, and need cause no worry on the part of a novice.

Testimony is given before a more or less elaborate court, and just as not all data are evidence, so much that is given in testimony is not evidence.

What may be testified to or related in court is only a small part of the evidence. The witness must learn to abide by the peculiar and at times fantastic rules and regulations governing the giving of testimony, which is usually grossly miscalled "evidence."

These rules have been frequently stated in text-books, and need not be now repeated.

One often finds it necessary to restrain the resentment at the folly wrought by legal routine, specially when, after having taken the oath

to tell the whole truth, one is prevented by a pure technicality which inevitably ensures a miscarriage of justice.

The essential part of a court is a presiding officer, who may simply have to see that the rules of procedure are complied with, or he may constitute the whole court or may occupy some intermediate position. Magistrates and masters constitute the whole court, and it is usual for them to dispense with some of the stricter regulations, though the rules of evidence should hold. Coroners usually combine the functions of magistrate with those of investigator, and the custom of the hearings allow a greater freedom, both in the manner of procedure and the scope of testimony admitted.

Courts of trial, whether before a judge or judges or by jury, are formal affairs, and have strict rules of procedure and arbitrary rules regarding testimony. There is and should be a certain dignity and formalism about the administration of the law.

The dignified medical man who appreciates the greatness of his profession should be ever ready to recognize the dignity of the law, and he will hardly need to be warned that he should maintain the dignity of his profession while recognizing that of the court, so that neither disrespect nor servility may appear. He should strive to appreciate the code of the courts as he would that of the consulting room or the scientific meeting, giving due deference to the presiding officer, and be ready to present and defend his evidence with strict regard both to his oath and the nature and methods of his opponents.

It is not uncommon for medical witnesses to receive rough treatment in courts, and a word is not out of place on such proceedings.

A good judge is a delight to an honest, capable witness, but a bad judge is not only a great annoyance, but a serious menace to the community as well as an abomination to decent witnesses.

The witness does not lose all rights on entering a court, though some judges, drunk with arbitrary power, have become insane over their supreme authority. Such judges are deadly to justice and terrible to the witness who is not hardened. Self-control, quiet modesty, honor, accuracy, simple language, readiness to answer proper questions from either party, and freedom from captiousness—in general, tact—will usually disarm even the bumptious judge; but the rampant judge only rages the more under such docility, and I have found it necessary to be short, curt, and firm even to insistence at times.

The witness has no redress unless the judge oversteps the bounds of decent behavior or breaks the rules of court, when appeal may be taken to a higher court, but such a course should be avoided, and the insults had best be submitted to quietly if possible.

Never should the witness allow himself to lose his temper.

Misunderstandings are not infrequent, and the judge not rarely indulges in criticism of a witness which may be justified in fact, or in the mind of the judge, or it may not be justified. If it is remembered that the standpoint of the court and of the medical man are quite different, and that the court has the presumption of rights and certainly has

the right to its own viewpoint, the wise witness will, so far as possible, seek quietly to adjust his point of view to that of the court. It will be remembered that technical language is always annoying to those to whom it should not be intelligible, and that medical jargon is just one of those technical languages, and that it is the duty of the medical witness to use simple terms at all times, and use his efforts to impress the facts rather than his great wisdom on the court. The lust for oratory should be left to the lawyers, and the witness box should not be mistaken for a pulpit or a rostrum, but used for the purpose for which it was made.

Remember the jury are laymen who at best are average men, and who should have the best you can give them in the way of fact and conclusion, always avoiding fine-spun theories, and separating carefully testimony as to facts from expert opinions. The impression you make can be left to take care of itself without stage play.

Several years ago I was asked to address the police surgeons of this city, and I then gave some rules regarding evidence. I was asked to repeat that address before a number of other groups of medical men, and each time it was so well received that I think it wise to introduce my rules of getting evidence at this point:

(1) Men differ so as to the power to gather evidence that all should stop, look, and listen; that is, readjust themselves to the problems at hand, and prepare themselves to be wholly alert to the whole situation.

(2) Estimate your own personal equation just as an astronomer does before he takes observations, for too much testimony contains the twist and the color from the individual who has not oriented himself out of his former habits of mind into the problem at hand.

(3) Fix your attention on the job and eliminate outside matters. At first take your problem as a whole, and then select details, but never lose sight of the problem as a whole. Never allow others present to divert your mind, nor allow your own impulses to mental wandering to have any indulgence, and the worst of all dangerous habits is talking.

(4) Fix the impressions of observation forcibly on your mind, not by long looking or vain repetitions, but by training the memory and attention to get for you clear, sharply formed pictures that can be stored away in the mind.

(5) Don't destroy evidence unless forced to, and then only after you have made good mental notes. This rule is very often broken, and I have seen what should have been an investigation turned into a carnival of destruction of evidence.

(6) Remember exactly what you have done. This rule will quickly engender a care to avoid doing useless things, and will eliminate what is so common in the postmortem room, paddling about among the viscera and futile pottering.

(7) Interrupt the process of observing at frequent intervals to rest the attention and to think over the significance of what has been observed. Don't imagine that close thinking and observation will go on together; one or the other is sure to suffer. Try to find the significance of what you are seeing before conditions have been changed by the

process of investigation, else you will want answers to questions when it is too late to go back and reobserve.

(8) Draw your conclusions cautiously, calmly, if possible quickly, but with the firmness of true thinking. You will remember that in spite of care and effort they may be incomplete, and will, therefore, avoid undue assurance.

(9) Reapply your conclusions to the findings after the pause for thinking, on the spot. This will help you to realize the value of not destroying evidence, as you will find your conceptions of the case growing moment by moment, and your later conceptions will differ from the first impressions so often that new questions will want answers. This will stimulate your technic and mental powers and give the real basis for expert opinions.

(10) Master the case, which implies that—

You will not be carried away by first impressions.

You will not neglect the whole for a part.

You will not inject theories where facts should be.

You will soon realize that you must be quick, but not hasty.

You will not expect to finish the case at once.

You will not see more than is before you to be seen.

You will not try to explain what you have not just grounds for explaining.

You will not neglect to use all of your powers of observation and thought.

You will not limit your investigation to what might be admitted as testimony in court.

You will ask yourself questions that you would ask the other fellow if he was presenting the report.

You will not be surprised to find many cases that you will recognize have not been finished, but you will know why they were not finished or you will not be satisfied with yourself.

EXHUMATIONS AND EMBALMING

EXHUMATIONS

Exhumations are often required to settle some question that has arisen after burial. They are seldom made unless such question has serious import; generally this is of a legal nature.

The identity of the body may be called in question, or the manner or cause of death may need further investigation. Such questions may arise through the discovery of new evidence which changes the aspect of a case, or through some doubt arising regarding accepted testimony.

Where large interests are involved, as in accident policies for considerable sums, the company may not have been notified of the death in time to insist on its right to have a postmortem. Sometimes suspicion arises and takes form in the minds of relatives, friends, or officials that some foul play contributed to the cause of death where a certificate of death was issued ascribing death to some natural cause.

When such persons become convinced that there is sufficient grounds for action the examination may be ordered by those in charge of the body or by the officers of the State. The State officer will take charge only when there is strong presumption of a crime having been committed. The family of the dead person may, however, be actuated by one of many motives. Thus, I have examined bodies of persons where a rumor was started that was detrimental of the memory of the one dead, and it was desired that such rumors should be stopped by thorough investigation and display of the facts.

Sometimes family discords are settled in this way. Where civil or criminal proceedings are pending in courts of law questions often arise which demand an examination or a re-examination, or more material for further chemical study. Questions of whether the coroner's verdict was correctly given and arrived at sometimes arise, when the coroner, the district attorney, or the court may order an examination to be made. A defendant sometimes seeks to strengthen his case by demanding the right to have the body examined.

Many sorts of medicolegal questions may lead to such exhumations, but specially those relating to homicide, suicide, abortion, damages, accidents, sexual crimes, incapacitating diseases, and other matters affecting inheritance and wills, insurance, etc.

There is practically no limit to the time after burial when such examinations can be made, but the value of the findings will depend on the preservation of the body and the nature of the evidence sought. Postmortems are still made on Egyptian mummies and museum specimens.

The first step in making preparation for such exhumation is the authority for it, to be obtained from a court or the proper State officer, or from the proper private persons. The next step is the securing of a permit from the local health authority to expose the body. There are local rules governing disinterring bodies that must always be complied with. Thus, in a case of infectious disease the body cannot be disinterred without special permit, which is often refused, except in cases of the rarest urgency, until a sufficient time has elapsed to destroy the infection.

In summer bodies cannot be removed from the cemeteries, so that all disinterments and examinations must be made on the cemetery grounds. The authorities of cemeteries require authority from the owner of the grave or a State authority, or both, as well as from the health authority, before they will exhume a body; also proper assurance as to the payment for the cost.

Generally it is best to employ the undertaker who buried the body to attend to the exhumation. The degree of caution required in this work depends on the nature of the case.

A chemical case may require the presence of all the experts at the grave, but in ordinary cases such precautions are useless. In summer, when the body cannot be removed from the cemetery, I prefer the early morning hours, but, if this is not convenient, the arrangement should be made with due regard for all parties, including those of the cemetery.

As a preliminary step, copies of all notes, records of death, and investigations should be procured, and the history of the case carefully collected, which will include a careful study of the embalming processes used, if any.

The identification of the body should be secured with all possible regard for the natural horror which we all have for evidence of decomposition in those who were near and dear to us. Women and children should be spared this affliction and men should be treated with all possible consideration. The undertaker who prepared the body should, if there is no objection, be present. The question whether the body may be removed from the coffin before the arrival of the examiner should be clearly determined, and depends on circumstances.

The postmortem changes must be most carefully studied, both as to nature and extent, and, so far as possible, their causes. The preservation of the body, as a whole and in its various parts, will depend on the condition of the body at death, the diseases present and the time of season and temperature, the undertaker's procedures, the place of burial and the time in the grave, the condition of the grave as to moisture, etc. The growth of mold and the action of larvæ and insects may be important when the body was not embalmed.

Postmortem accidents should not be forgotten as a possible source of error in judging of findings.

Changes in the coffin and clothing may be significant. The examination should be conducted whenever it is possible in a public or private morgue with suitable conveniences, but in summer it is necessary to

improvise a shelter at the cemetery. The examination may be made in the coffin, raised on supports; or on boards, covered with newspapers or a rubber blanket, such as undertakers use.

In cases of suspected poisoning the most rigid care must be taken to prevent contamination of the material to be saved, and if possible the chemist should be present to receive the parts after examination.

EMBALMING

In this country the art of embalming has been developed very rapidly, and today it is so common that no one making any number of postmortems can long escape having to cut an embalmed body.

It becomes, therefore, more than ever necessary for us to gain a clear understanding of the principles and processes of the art, as well as the effects on the tissues. The tendency today is toward the almost exclusive use of formaldehyd among the average undertakers. There are a few men in the business who take an interest in their work, and who are not pleased with the resulting putty-colored corpses without expression, and these men still use other methods to obtain artistic results. It would be unnecessary for us to go far in our study in this work if the literature of embalming could be referred to. The only creditable book on the subject is out of print and is not to be obtained in the open market.

Historic.—Embalming seems to have arisen independently in several places. Each seems to have been so situated that bodies were accidentally preserved, either in caves or on account of the extreme dryness of the air. Early man retained the imitative faculty of his ancestors and added various little varieties of his own. The art of the Egyptians has long been the wonder of the world; and the crude European embalsaming was probably suggested largely by Herodotus' description of the Egyptian process, but is now only a curiosity which is interesting chiefly because it is absurd.

Anything that had an odor among the native herbs, all the spices, most of the gums and resins and balsams, and most of the plants containing tannin, various salts, acids, and spirits found a place; and many oils, also oil of turpentine. With the discovery of antiseptics their use in embalming quickly commenced and gradually spread, each one being exploited in certain places, and often the formulæ were kept secret.

Salts of aluminum, antimony, arsenic, calcium, copper, iron, lead, magnesium, mercury, silver, and zinc, and many salts of potassium and sodium and ammonium; bromin, iodin, chlorin, sulphur, and their compounds; gases, carbon monoxid and dioxid and those from sulphur and chlorin; various acids, acetic, benzoic, boric, gallic, salicylic, tannic, tartaric, and many others—usually combined. Commonly, alcohols, carbolic acid, chloral, chloroform, glycerin, sugar, and thymol, and recently enormous quantities of formaldehyd. It is impossible to obtain reliable data regarding the action of even a small portion of these drugs on the tissues.

What we can give is but a slight indication of the problems to be

met rather than a complete guide. A few practical points we have gathered in a rather large experience will, we trust, help to develop the subject.

The wise undertaker does many other things besides embalm the body, each of which is intended to change its appearance. He ties up the jaw so that when rigidity sets in the mouth will be closed; he closes the eyelids; he smoothes out the wrinkles and works out any bad expression; he rubs away spots of discoloration; he elevates the head to drain away the blood; he extends the thumb and fingers so that the characteristic (in about 60 per cent. of cases) "corpse fist" is overcome; he straightens the limbs and ties them together; he punctures the abdominal organs to draw off the gases and fluids; he may put a pad or support under the chin instead of tying up the jaw, or he may stitch the gums or lips together. He should anoint the face to prevent drying, and generally shaves and washes the body, not infrequently using quite warm water. Some put cloths wet with embalming fluids over the face and hands.

They may put the body in an ice-box with large pans which rest on the sides of the box, but ice may be put directly on the body or the pans may rest on the body. At times repairs are made to wounds—sewing, trimming, painting, even tying vessels, and making extensive repairs. I have seen gunshot wounds cut away, sewed up, and painted over quite skilfully. Finally, he may injure the body in handling, at times quite seriously. If he has completed his work, the fluids have been drawn off and the embalming has been carried out. This varies from simply spilling or pumping into the cavities a lot of preservatives to the complete injection of the body.

It is necessary, therefore, to find out from the embalmer just what he has done. He may not wish to tell all, and if quite frank he still may not know the composition of the compounds he has used. It then becomes necessary to know the general effect of the common substances. The methods vary among even good undertakers in the same locality. One man will prefer to wash out the blood with salt solution, another uses a trace of ammonia before beginning to inject a solution. One relies on a compound solution, while another uses a series of injections. Some use the hypodermic syringe freely, others never heard of such a thing. One man forces in the fluid and later draws off the blood, distending the vessels and heart, while another opens both vein and artery at the same time and uses only slight pressure behind the fluids.

The strength of each component in a fluid and the method used, as well as the condition of the body in all particulars, all influence the results, and everything the embalmer does has a bearing on the interpretations at the postmortem.

It is well-nigh discouraging to have to make an important postmortem after an elaborate embalming, and because of these difficulties, and because of the way embalming processes disturb and destroy evidence, it is extremely important to have all serious cases let alone.

Coroners and medical examiners are compelled to be very strict about aspiration or injecting of bodies pending their investigations, and many a criminal case has fallen and justice has miscarried through the carelessness or connivance of undertakers.

It becomes necessary at times to investigate embalmed bodies, and, in spite of the great difficulties, such examinations must not be neglected. Rather should the special difficulties stimulate us to greater efforts to overcome the mischief by most carefully estimating just what has happened and correcting the pictures we find, so that our view of the case shall truly represent the conditions before the embalming took place. Embalming is not always a hindrance, because it preserves much that would be destroyed by decomposition, and if we learn to interpret embalmed tissues critically and properly we have plenty of excellent evidence where we would have little or nothing if the body had been allowed to rot.

Taking up, then, certain of the processes in detail:

Aspiration.—This is usually done with a long trocar about the size of a No. 30 sound, and attached by tubing to an aspirating bottle. This trocar may be plunged into the tissues anywhere and simulate wounds. I have been hurried out to investigate stab wounds that were made by an embalmer. The usual place to introduce this trocar is the navel, where it shows least, and the careless operator at a postmortem may overlook it. It is customary to make many subcutaneous punctures of the organs without withdrawing the trocar, the object being to draw off the fluids from the stomach, bladder, intestines, heart, and vessels. The damage done is often very extensive, and the loss of these fluids greatly changes the picture of the organs. The fluids are not all removed, and some may find their way into out-of-the-way places and produce marked changes that are very puzzling.

Thus, a lot of sour gastric contents bathing the pancreas is pretty sure to mislead the uninformed operator. Bile, blood, stomach and intestinal contents of all sorts, even pancreatic secretion, urine, and abnormal fluids, such as pus and cyst contents or inflammatory products, all these may occur and their effects may be analyzed in favorable cases, or the changes may be so great that we are compelled to give up the whole problem.

In giving up a serious problem the general rule holds of observing clearly just what the conditions are and noting them, even though at the time we are unable to interpret them. At times we can clearly see and state that the conditions are so changed that the evidence is destroyed.

Cavity Injections.—Usually following the withdrawal of the fluids by aspiration some embalming fluid is thrown into the cavities through the trocar; occasionally the fluid is poured in through a cut in the belly wall and diaphragm without aspiration.

If the aspiration has been clumsily done the mixture of hardened blood and embalming fluid that is met with on opening the body is most annoying, and instruments, gloves, and tissues soon become a filthy mess.

If the embalmer feared putrefaction he has probably injected extra strong fluids, and the organs are like leather, and carving must be substituted for dissection.

To cut a body thoroughly hardened by modern methods for some months is very exhausting labor. One does not have time to soften the tissues by soaking in water, even if such a procedure would be a real help, as at times it may be. The working in these powerful compounds is often annoying, as they generally contain formaldehyd.

The Injection Through the Vessels.—The majority of injections are made into the brachial artery, though they may be through the common carotid, the subclavian, femoral, or even through vessels in the cavities. Where the circulation is blocked the multiple method is resorted to; this matter is, however, of easy determination. The blood is forced ahead of the fluid, and if there have been clots in the veins they will be more or less dislodged and forced toward the right heart, and if the veins have not been freely opened to allow the outflow we may find masses of worm-like clots in the pulmonary artery.

Such a case, having medicolegal importance, I had to cut in the presence of several professional persons, and the scorn displayed by one of them because I failed to recognize a pulmonary thrombosis was most edifying. When the veins have not been freely opened the vessels show a type of engorgement that should not mislead an expert, but might a novice. The condition of all tissues will be changed by the fluid so far as the injection was complete and equal, but it is very common to find a failure to wholly embalm a body, and one or more organs or areas will show only slight if any change. At times this helps us greatly, and when we come to make our estimates of change by the fluids such failures are often the greatest helps we have, because side by side we have in the same tissue part embalmed and part not.

Owing to the action on the blood, embalming causes much annoyance when bruises or small hemorrhages are to be studied. The conditions found are apt to be markedly less than before the injection; this is further accentuated when fluids containing bleaching agents, such as H_2O_2, have been used. Dilute fluids are very apt to cause a swelling of certain parts of the tissue by simple osmotic action; this is at times overcome by the use of glycerin and salts in the fluid, also by adding alcohol. During the fixation of fibrous tissue there appears to be a tendency to distort, as by contraction, which is at times rather marked, specially in the yellow clots found in the heart. It is not safe to try to reason too closely as to the concentration in the tissues even when the amount of fluid used and its composition are known, as highly vascular tissues are more quickly changed in the same body.

The use of salts of arsenic and mercury is prohibited by law in certain States, but occasionally they are used on the sly. In such cases the color effects are different from those produced by formaldehyd. Zinc salts are still used at times. Alum is frequently used as a hardening powder.

In studying an embalmed body we are forced to constantly correct the results of observation and to reconstruct our estimates by eliminat-

ing the effects produced by the processes that have been employed. The most common fluids used in this country contain varying amounts of formaldehyd. If the examiner has had large experience in the laboratory with specimens preserved in formalin he is less confused by the findings, but more apt to forget to regard the findings from the proper standpoint; that is, from the standpoint which considers all tissues in terms of the fresh conditions rather than from the perverted basis of pickled specimens.

The changes brought about by the use of fluids will vary with the strength and composition of the fluid used, with the amount of fluid actually injected, with the time it has remained in the vessels, with the condition of the tissues, with the amount of blood in the parts before and after the injection, and with the success with which the injection has been forced into all parts of the body. This will depend on the force used and the free passage through the vessels without obstruction by clots or injury by overpressure or rupture from disease or decomposition.

The amount used varies greatly, some embalmers simply injecting the arteries with a few pints, others continuing the injection until the veins are filled.

One can estimate the capacity of the blood-vessels as about one-thirteenth of the body weight or, roughly, 6 quarts. As much of the venous blood is driven into the lungs and all clots remain in the body, one finds the common rule is to inject less than this amount. The concentration of the fluid used varies greatly. It is commonly the practice to use a rather weak solution for the vessels and a strong one for the cavities.

The formaldehyd in the fluid causes a fixation of all the albuminous parts in the body, causing them to become firm and hazy, with considerable change in color. The yellows are turned to dirty whites and the reds to dirty grayish browns. Blood is rendered firm and brittle, and with weak solution retains its red color, but with strong solution becomes dusky brown. The lungs show very marked but variable effects, depending on the concentration of the fluid and the amount of it, and this is further modified by the condition of the tissue. This is the most markedly changed organ, and where the question is one that depended on the study of the lungs the embalming is most confusing.

SPECIAL TOPICS

THERE are certain groups of problems which, from their frequent occurrence and importance, deserve a brief consideration even in a general work on postmortems, though their full discussion must remain part of other treatises.

One does not always have reason to suspect the true nature of a case until the examination is well advanced, and unless he is prepared by at least a partial understanding of the significance of the findings he may finish his work without realizing that he has been destroying valuable evidence in a medicolegal case, and may, in fact, cause a certificate of death to be issued for some natural cause. I have seen so many of these occurrences that I am deeply impressed by the great need of a broader outlook on the part of those who are to perform postmortems for any purpose. I do not now refer to excusable or inexcusable overlooking of lesions which any one ought to recognize on sight as serious, but to those things which require more or less skill and knowledge for their proper interpretation, and which ought to be better understood than, at present, they are by those who have had an exclusively laboratory training, or whose chief aim is to become eminent in the domain of pathology or any of its minor branches.

ABORTION

While the crime is generally so defined as to include not only actually performed abortions, but also attempts to induce abortion, even though the woman is not pregnant, one seldom is called on to discuss any but real abortions following actual pregnancy.

It is always important to determine not only the fact of pregnancy by the means already described, but to judge as accurately as possible, under the circumstances, of the stage of advancement and the time since it was interrupted. The question whether the abortion was the result of natural or accidental causes, or was due to some interference, can generally be at least partly answered.

There are a few conditions which will almost inevitably cause a pregnant woman to abort. I well remember one case where a drunken physician neglected a woman who had aborted naturally, and then to cover his crime sought to scare the family by threatening to disgrace the woman by revealing that she had had a criminal abortion done. Subsequently he caused it to be rumored that such an abortion had caused the woman's death. The husband in great moral distress came from a distant city to consult me.

At the examination following an exhumation of the body, which had been embalmed, I was able to show conclusively that there was a very extensive scar in the uterus which had resulted from a neglected rup-

ture at a previous childbirth, which was so large and serious as to make it impossible for the uterus to carry any child to maturity. The reputation of an innocent woman was saved, and the scoundrel who had allowed the original injury to go uncared for, and had subsequently been guilty of criminal neglect during the final illness, was compelled to leave the city without any legal proceedings being even begun. This case also illustrates the moral effect of a postmortem.

There are many conditions which may be discovered at the postmortem examination which would be detrimental to pregnancy, and such must always be carefully investigated, because on such conditions are based the defense that the abortion was a therapeutic necessity and was done to save the life of the mother. The law here differs with a certain school of theology in allowing abortions to be performed where it can be demonstrated by competent medical men that the death of both mother and child was imminent, and that an operation offered good hope of saving the mother. Such legal recognition of therapeutic abortion is often used to cover criminal operations, and at the autopsy one should be very careful to determine whether such a claim is just or mistaken or utterly false. At times such a determination is easy, often it is only partly successful, at times it is difficult or impossible, as in all medicolegal problems one must be cautious, accurate, and absolutely honest. Even if the theory of crime appears well grounded, such theory should not be allowed to interfere with the true interpretation of findings. It is proper, however, to give an expert opinion on evidence and findings where the findings alone do not warrant such an opinion, but it is never proper to confuse evidence and findings even while testifying after the evidence has been admitted on which such opinion rests.

In criminal abortions one must consider the possible, the probable, and the evident factors which caused the termination of pregnancy, and the results and sequelæ of each and of all of these factors.

It is not unusual to find several attempts have been made before the final or successful one, and there may be evidence of previous operations or of poisoning by drugs, used in the hope of causing an abortion. One must always consider the treatment subsequent to the actual operation, and whether the findings are due to such treatment or to the original act. One is often called on to discuss the nature and propriety of such treatment, specially if it was given by the abortionist. I have seen not a few criminal abortionists set free because they stoutly maintained that they were called to treat the woman after the abortion, which, of course, was perfectly true, but in no way relieved them of responsibility for what they had previously done, but they were able to claim that the injuries observed at the postmortem were either accidental or necessary at such subsequent treatment.

The problem is often one of great difficulty, and all of the possible interpretations must be considered while making the examination, but it is not proper to neglect to determine in so far as the conditions warrant what was possible in the particular case, and what was probable and what must have been.

ASPHYXIA

Asphyxia has been briefly analyzed under Lesions, but from the medicolegal point of view chiefly interests us in relation to violent mechanical means used to cut off the air-supply.

Added to the evidence of serious asphyxias there are usually other indications or signs of the manner by which the condition was produced. It is the reading of these signs which causes the many difficulties in medicolegal cases about which many experts and pseudo-experts have developed such remarkable theories.

It need hardly be pointed out that in making the best possible interpretation of the evidence we are compelled to recognize grades of assurance. In one case we may be able to assert positively that the asphyxia arose in a definite way, in others we cannot be so sure, and can only say there is no reasonable doubt, though there might be a highly theoretic or unreasonable one, while in a very limited group of cases there is and must remain a real doubt.

To find a man dead in the water and with clearly marked asphyxia is far from proving that the man was drowned, though in the majority of cases such a conclusion would be in accord with the facts. Add to these, however, that the asphyxia was of the highly sthenic type, and water was found in the smaller air-passages or in quantities in the stomach, and we have multiplied rather than simply added to our assurance. Suppose he has no water in the air-passages beyond the glottis, but we find the glottis closed and no evidence of violence, then we are practically certain that death came by reflex spasm and resulting closure of the glottis following the irritation by the water. If we add, still further, well-marked "goose-flesh" and retraction of the scrotum no reasonable doubt should remain.

Suppose, however, a man is found in the water at the bottom of a hold of a vessel, and the rescuer is overcome by gas while attempting to recover the body. No water is found in the air-passages and the glottis is open. The question of drowning may be dismissed, as death was by asphyxia due to the gas.

These brief outlines of actual cases serve to illustrate the need of care and alertness in the study of such problems.

Asphyxia occurs by gases, by fluids, often by spasm of the glottis in drowning, rarely at other times, by edema of the glottis, by foreign bodies, by compression of the chest or of the throat, or by smothering, by edema or disease of the lungs; any of which may result from accidental, suicidal, or homicidal happenings.

Mechanically produced asphyxia usually leaves marks which are to be carefully studied. Infants are often overlaid or smothered by clothing or while nursing, and in such cases no jury will convict a mother unless clear evidence is produced of purposes. Workmen partly buried by earth, sand, coal, or grain may have their respiratory movements entirely stopped; in such cases the history is far more convincing than the findings at the postmortem, though both are essential. Persons

who have been strangled by some object at the throat or throttled by hand-pressure show changes in the finer tissues between the skin and the air-passages because the elasticity and resistance of the parts protecting and keeping the air-passages open are such as to require force which will disturb the delicate overlying structures. Only in the rarest instances is it possible to have the air cut off in the throat without clearly discoverable marks in the tissues remaining. In strangling and hanging by means of some constricting band or cord about the throat there is apt to be evidence of severe violence, though this varies greatly under different conditions. External marks when present are generally conclusive, but may mislead the incautious.

BURNS AND SCALDS

Burns and scalds are apt to be limited to a definite area, which may be of considerable significance. The degree has been considered under Lesions. The presence of foreign substances, such as coal oil in case a lamp was thrown, should be noted. The extent of the area affected has been rather overdiscussed; estimation is not nearly as simple as it might appear, and few estimates are accurate. The best way to arrive at a quick estimate is to spread out the underclothing, including socks, take lengths, multiply by average widths, and then by 2, avoiding measuring both parts where garments overlap.

The average hand is about 3 by 7 in. = 21 sq. in. $\times$ 2 = 42 sq. in., to which add thumb, about 9 sq. in., and lateral surfaces of the fingers, about $\frac{1}{2}$ by $3\frac{1}{2}$ in. by 8 = 14 sq. in.—total, 65 sq. in.

There is little value in accurate measurements because we can only approximate the other factors. The question whether flame or hot fluids or steam has entered the air-passages is far more important, as the results are apt to be most serious.

The question of severe general heat should not be overlooked, though the problem is difficult to solve at the postmortem.

HOMICIDE

The question as to whether an injury, whether by violence, neglect, or poison, was due to the purposeful act of another—that is, homicidal, or whether the cause was accidental or suicidal—is often a difficult one to determine. Usually it is settled by other evidence, but often the medical evidence is of the utmost importance.

There are few injuries which are necessarily homicidal, and it is often impossible from the study of the lesion alone to decide the question. Peculiar characteristics at times help us to very definite conclusions in certain cases. If during the careful study of a lesion we find evidence of purposeful infliction, we must adopt the medicolegal point of view in considering the lesion and such evidence.

As soon as we find a number of lesions, as of repeated blows or stabs, we are generally warranted in assuming homicidal intent. The question as to whether such lesions could have been inflicted by a person intent

on committing suicide is a most practical one. It is often stated by pseudo-experts that a given injury could not have been inflicted by the dead person in attempting suicide. Such a statement should only be made after the most careful study and deliberation and the avoidance of crude theorizing tendencies.

I have often been astounded by the ease with which the untrained, incautious, and incompetent draw positive conclusions entirely at variance with conditions that exist or with right thinking.

To avoid such errors is not always easy even after wide experience and great care, and often requires a full study of the surroundings as well as of the body, nor is it proper to neglect the psychic element of the obtainable history. I find it always desirable to consider every argument that could be adduced by the defense when I am convinced that I have a true homicide. This habit has saved me several times from overlooking slight peculiarities of the lesions which had definite values. Such a method of combining observation and thinking may save one from accepting a mistaken hypothesis and prevent a miscarriage of justice.

The degree of injury inflicted, both directly and indirectly, must be determined in such a manner that the conclusion can be presented to a body of laymen. Fine measurements and unfamiliar units or terms serve but to becloud the issue. The estimates must remain as estimates, though so far as possible they are to be backed by relevant data, but if the data alone are presented the effect will be a temptation for the incompetent to draw false conclusions.

If your conclusions are properly drawn, and you have been duly critical of your own work, you will have no difficulty about having sufficient data to convince any true, honest expert that your conclusions are at least carefully and honestly made. My rule is to do my work as if I expected to have the best living expert on the other side at the trial. Then, if there is a miscarriage of justice through the acts of the court or the lawyers, witnesses, or jury, the responsibility must rest where it belongs. The details of how to determine the purposefulness of injuries and the peculiar characters that belong in these three groups of injuries would carry us far beyond the limits of a paragraph in a work on postmortems. The essential and fundamental thing is to remember that the point of view includes everything in the anatomy, physiology, pathology, physics, chemistry, and psychology, but that none of these nor all of them are adequate to the proper comprehension of the problem. It is a higher and separate branch of the medical sciences to which all others may contribute.

INSANITY

Insanity forms a very large part of the bulk of the contents of the literature on legal medicine, but there is very little about postmortem findings in such literature that is systematized so as to be of use. A few words may, therefore, be of help:

Inherited or congenital mental conditions usually are accompanied by physical defects that are fairly well marked; these are called stigmata,

and should always be carefully observed, and specially where any question may arise as to the significance of the mental conditions. Trophic lesions and conditions which show either congenital or acquired defect, deficiency, or abnormality of the nervous system become of prime importance. The condition of general nutrition may be of the utmost significance. Various chronic diseases or peculiarities clearly point to nerve lesion, either as cause or effect.

The bones, joints, skull, skin, hair, nails, teeth, mouth, tongue, fat, muscles, facial development, and expression, all indicate something of the physical basis for the mind.

Alcoholism, specific diseases, evidences of violence, habit, occupation, each and all may affect either normal or abnormal types.

The sexual organs are most active factors in many types of insanity.

Digestive derangements of definite types follow and at times lead to central nervous disorders. Actual lesions within the brain case, whether of the bones, the vessels, the membranes, the parts of the nervous tissue or the pituitary body, require painstaking study and cautious interpretation.

Here as elsewhere the history often helps us to understand the findings, as the findings often help to explain the history.

A thoughtfully conducted postmortem will often be of great value in difficult cases of insanity.

There is a theory held by some neurologists that the macroscopic findings at a postmortem are of little or no value. Such a theory is quite as absurd as would be one that maintained that a physical examination of an insane person during life was useless, and for very much the same reason. We must always remember that the mind is profoundly affected by physical and chemical conditions in the body, and that certain concomitant variations, whose significance is not always clear, go with mental disturbances, while other effects of such mental conditions are fairly well recognized and understood.

SEXUAL CRIMES

Sexual crimes form a complicated group that require the aid of advanced psychology for their complete analysis. The anatomic findings are comparatively simple.

In many cases there is more or less evidence of violence which is generally easy to interpret. The law regards two large groups, one about the normal act, the other about abnormal ones. Rape constitutes an attempt to procure the normal act, and this may be completely accomplished or only in part performed. When accomplished, the effect will vary with the condition of the victim, from no perceptible change in a person to whom the act is no novelty to extensive injury in a virgin.

The attempt on an immature person is strictly an abnormal act, and may be an intentionally incomplete act, in which case no anatomic violence is found. The presence or absence of the male discharge is im-

portant when actually found, but of minor importance when not found. Violence done to other parts during a struggle preceding the culminating act may be very significant and may constitute all the evidence that remains. The presence of venereal disease may be significant.

Abnormal sexual acts vary enormously with the peculiar type of the actors. I have seen several cases where asphyxia by overlying was the only bodily mark, though the clothing is often found either disarranged, soiled, or injured. The act is sometimes continued after the death of the victim, and then the evidence is more definite. I have seen the sphincter widely dilated, which does not occur normally. Theories regarding anatomic changes resulting from habits do not apply to most cases, but only to a special few, which are to be regarded as extreme ones, and the absence of such findings in no way influences the conclusion in any given case. Where possible the actor should be examined at once for any evidence of the act, but negative evidence should have little weight.

I remember one serious case, where a degenerate attempted connection with a little girl, and came near getting free because certain physicians thought that undisturbed smegma was a sure sign he had not committed the crime. The criminal's own testimony caused his conviction after the medical errors had been cleared away, and subsequently obtained evidence convinced the theorizers of their error.

SEQUELÆ

Sequelæ, such as infection, shock, hemorrhage, often play a varied part in medicolegal cases.

At times they render the case clearer, while often they tend to obscure it and make its study difficult. The quickly and necessarily fatal injury is generally a simple matter for a court to handle, but many cases become intricate by reason of one or more sequelæ. It becomes necessary at times to enter into very elaborate estimates of the significance of the original injury and of each subsequent complication before one can give the true report that a court wants to have before it. Often the question arises whether there was contributory negligence on the part of the dead person, or lack of skill on the part of those who took care of him.

Thus, one case I had died, after some weeks, of a volvulus caused in returning the bowel through a stab wound in the belly. Another case was doing well until the patient tore off the bandages, stating at the time that he was well and that they annoyed him. Such complications are far from rare, and may tax one's knowledge and judgment to the utmost to arrive at the proper conclusion.

SUICIDE

The chief problem of suicide is the psychologic one. While this is apparently widely removed from the art of making a postmortem, it is actually an important part of the interpretation of the findings. The

suicide is mentally disturbed, disordered, or diseased by some internal or external condition, and if some internal condition which was associated with a tissue lesion is found, it is important that it should be observed, and proper conclusions or deductions made regarding the significance it may have in fixing or excusing the responsibility for a moral act. Suicide generally implies some depression of the mental and moral tone which may be noted by the peculiar actions, or the condition may be concealed, or the attack may be sudden or fulminating. The manner of accomplishing the act very often shows the type of the disorder. At times the means used may be interpretable. The history of the case generally forms an important part of the investigation, and the surroundings may furnish valuable information. If the act is impulsive or done under sudden impulse, as in jumping from a high place, there may be no evidence of premeditation, though there is apparent purpose. The impulse to jump from high places is felt by many who never dream of committing suicide.

It will be noted that there is a far greater range of type and variation in predisposing and exciting cause, in impulse and premeditation, and in biologic significance in this act than is generally even suspected. The commonest predisposing factors are sexual worries, with or without physical excesses. Other emotional disturbances of all possible kinds may be associated with the basal disorder. The findings generally show purpose, and often point to the manner of performance of the act.

Men more often choose shooting, cutting, or hanging, while women prefer poison, and when using firearms they less often choose the head.

Poisoning by gas requires careful investigation of the condition, as the mere examination of the body usually tells nothing of value in regard to how such poisoning occurred. Conclusions regarding drowning must be guarded and often require much close thinking. The case of a single woman who is pregnant, and is found dead in an out-of-the-way place, may be either a homicide or a suicide, but is rarely an accident, while the drunken man who was seen staggering in the direction of open water is apt to be an accident. Some of these cases are never definitely settled. In such cases slight marks are often of the greatest importance.

It is well to have a general idea of the relative frequency of the occurrence of the different types of suicide, as of homicide and accident, but too much reliance on such statistics will readily mislead one, for the particular case may happen to be one of the exceptions. Arguing on the theory of probabilities or on any other mathematic formula is dangerous and generally worse than unwise, and one may at once suspect the intelligence of those who indulge in such a practice. Above all, it is necessary to avoid hard-and-fast rules by which we are to determine whether a case is one of suicide, homicide, or accident.

Much stress has been laid on right and left handedness as a factor in the position of wounds, and many grievous errors have resulted from ill-considered snap judgments; the matter is of minor importance in most cases.

We must add one more caution, that is, that the family of the dead person will often attempt to mislead the investigator by suppressing facts or even making false statements, either to prevent the unpleasantness of a suicide verdict or to fraudulently collect insurance. In this connection it will also be remembered that not a few suicides attempt to cover the act in order to protect their families from the natural consequences.

WOUNDS

Wounds, from a legal point of view, comprise all bodily hurts, and not the limited group described in surgical practice.

Unless one has a very clear and reliable history one cannot tell before the examination whether an injury was serious or not. The location gives us a general idea as to what might have occurred, and the general character and appearance of the lesion often helps us materially in making a preliminary estimate of how serious the injury was. Often there is little or no history, and we are called on to determine just what injury was done and how it was done; in such cases we must be very cautious in approaching the lesion lest we destroy valuable evidence. Even light handling, moving the part, or removing the clothing may so alter the condition as to do irreparable damage. The superficial examination shows us whether we have a clean cut, a bruised cut, a rip, a bruise, a crush, a denudation, a rub, a scrape, or merely a swelling or an indentation. At times we must suspect a wound when later on we find the lesion is of a different nature, even where some form of surgical wound appears on inspection.

Not infrequently a wound has been produced by a surgeon in treating some lesion, and then we want to know what that lesion was and the treatment used before we can properly judge of the condition existing before such treatment. Also one finds postmortem injuries of various sorts; some by accident, some made for a purpose, as by the embalmer. The surface mark will vary with the position, even if produced by the same sort and degree of violence, owing to differences in tissues affected and in the underlying structures, and the transmitted violence will depend on their ability to absorb or transmit force and on the nature of adjacent organs to which such force is carried.

Thus, a blow with a club on the thigh not only produces a different mark, but vastly different effects below from one on the head, but this well-recognized difference carries with it much that is not so well understood regarding different parts of the same general area. Thus, a blow over one area of the head has a widely different effect from a similar blow on another part of the head, even though the two areas are very close together. A knowledge of the architecture of the part is necessary to form such an estimate of the probable effect as will enable one to formulate the proper method of examination to give the best results.

In this architectural comprehension there must be a clear picturing not only of the bones and their size, shape, structure, and masses, but of the vessels and of their size, and the effect of violence on them in the

different phases of distention. Nor should we neglect the textural and physical properties of all the affected or possibly affected tissues.

There must then be a simple but clear idea of how force can be exerted, which means not only the amount of force exerted as measured in foot pounds or any other unit, but of the amount and the speed with which it is sent into the part, and what differences in direction of impinging forces may mean.

We are all familiar with the differences in force and speed and angle of striking of a thrown or batted ball, and we know that a glancing contact produces very different effects from one which hits squarely. We also know that a hard ball differs from a soft one of equal size and weight and swiftness, but many find a tendency to become confused when called on to apply these simple principles to wounds by other sorts of instruments.

FIG. 272.—A VERY UNUSUAL SUICIDAL WOUND.

The retraction of the tissues toward the body is well marked. The "hesitation" notches on both sides clearly demonstrate the fact that a knife was entered on both sides, as do also the nicks in the esophagus. These cuts begin on the back of the neck. The notches on the right side show greater irregularity and are more numerous than on the left. The great vessels were all severed, and death followed both from hemorrhage and by inhaled blood within a very few minutes. The instrument used was a butcher's knife. The whole constitutes one medicolegal wound, but several surgical wounds were inflicted, and many separate injuries are combined.

To these principles must be added the effects of a wide range of objects of almost unlimited variation of hardness, elasticity, size, weight, and velocity.

Still further, we must add the size and shape of the striking surface, which varies from a pin-point to a razor-blade, and to a large surface. The pin-point can produce a puncture or a scratch, while the razor-blade may either section or slice, and these may be in any plane. When

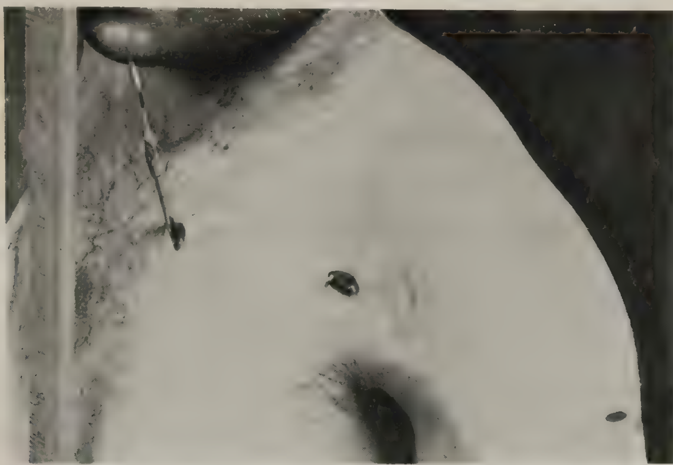


Fig. 273.—Three Stab Wounds—Homicidal.
The one with the sound in it was the fatal one. Note the characteristic gaping of the wounds caused by surface tension.

we begin to study the effects of irregularly shaped bodies we pass from simple to more or less complex results. We are called on to estimate from the findings what sort of surface was in contact and the direction of application. While we are well aware that similar marks may result from very different objects under different modes of application, we are

Fig. 274.—Four Stab Wounds of Coat.
The one at the extreme left corresponds with the fatal wound on the body. (See Fig. 273.) The one at the extreme right did not reach the body.

often obliged to find from the deeper parts of the lesion those peculiarities which shall enable us to form right deductions as to which of those possible causes of the mark caused the whole lesion.

This is often a matter of great difficulty, and no amount of practical experience should tempt one to make a hasty judgment.

It is absolutely necessary to remember the inertia of the body as a whole and of its various parts; also that the body moving against an object that is at rest produces the same effect as if that object were moving in the opposite direction with an equal momentum.

A fall on a brick, however, is not the same as a blow from a brick, because if the momentum is the same in the two cases the velocity must be very different, and effects produced on tissue vary quite as much if not more with the velocity variations than with those of momentum.

The effects of violence consist of (*a*) the mark on the surface, which varies from an indentation, such as is seen following constant pressure,

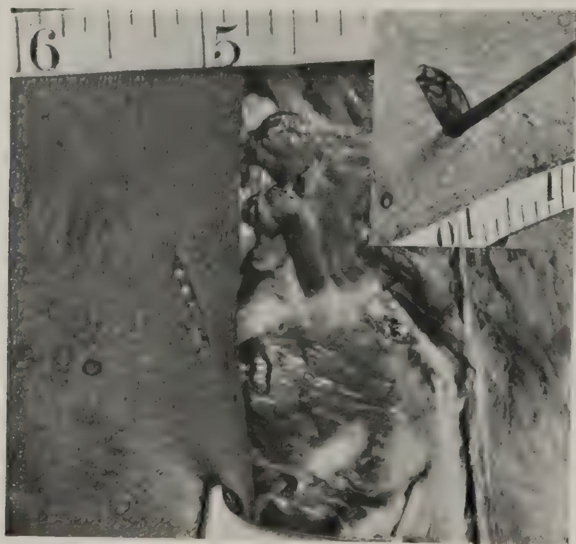


FIG. 275.—WOUND OF HEART THROUGH MIDDLE OF STERNUM.

In the upper right corner is a small photograph of the external wound in the skin; it shows gaping caused by the elastic tension of the skin. A small probe was gently placed in this wound to show its general direction. Note the distribution of skin markings. The main picture shows how the skin retracts and allows the true nature of the cut to be observed. Note specially the skin markings, showing tensions of the surface produced by the elastic contraction of the deeper layers. The wound in the sternum is seen directly under the left corner of the small picture. These pictures show well the interesting phenomena of skin wounds and something of the way to study them.

to the various forms of laceration. Also many signs of side motion are to be noted. Actual severing may take place by cutting, squeezing, ripping, or shearing.

(*b*) The deeper tissues show either of these effects with the secondary effects dependent on the inequalities of the tissues, and secondary changes which more or less quickly modify the condition of the wound.

(*c*) Transmitted effects, which pass either directly along the line of the blow or spread more or less diffusely, or by reason of the nature of the tissue change the direction of the force entirely. Such changes of direction are best shown in fractures, dislocations, and sprains.

(*d*) Vascular disturbances, which are usually marked in all extensive injuries, the vessels being violently compressed, may cause waves to be propagated, causing rupture either at a near or remote point. Actual rupture or severing is common and contusions are frequent, which later give secondary changes. The general presence of hemorrhage should not mislead one into the error of judging of the violence of the injury from the amount of bleeding, a common but inexcusable error; nor should one forget that in all open wounds, where the blood can freely escape, the

Fig. 276.—Wound of Heart—Sternum Raised.

A probe passes into the wound in the pericardium. The wound passed through the area where the pericardium is attached to the sternum. (Note the dark spot on the under surface of the sternum, to the left of the middle.) The blood, no longer restrained within the heart, has been forced into the tissues of the whole region, extending well out into the layers of the pericardium. This is well shown by the dark area. Note that while the pericardium is distended with clot, it is not markedly bulged; this being caused by the slow leaking of serum from the external wound. The cut in the sternum is seen near the midline.

evidence of bruising is far less striking at the first view, but careful examination shows tissue crushing often far in excess of the appearance of swelling. Nor should the actual amount of blood mislead us as to the amount or nature of the violence, because it will depend far more on the anatomy of the part than on the violence. It is so obviously impossible to here consider in detail all the types of effect because of their very great variety, and for the same reason it would seem clearly unwise to attempt to use the very limited nomenclature of wounds, so often

taught, if we wish to convey reasonably accurate impressions. It is better far to avoid technical terms and to use common words.

The **examination** of a suspicious area will depend on what it appears to be as well as on the obtainable history. In general, the surface and any foreign substances in or about a wound should be scrutinized before touching it. Then, if necessary, such foreign substances will be removed.

The dissection should generally be begun well to one side, so as to be able to examine the normal tissue about the wound, first to gain a basis for comparison and to avoid destroying evidence, then work cautiously toward the lesion, either by layer dissection or slicing or by actual section through the area. Probing is to be avoided in general, but, like most general rules, there are many exceptions. In the dissection we are to be specially careful to judge of the surface tension of all affected structures as well as their power to resist or absorb various sorts of violence, and the distribution of tissue elements or types in the mass of structure affected. This applies specially to fat, muscle, bone, and fibrous material. Evidence of retraction, contraction, crushing, swelling, repair, necrosis, sepsis, bleeding are all to be regarded as indications, not simply as data.

Wounds involving the visceral organs require several special cautions. Organs which move with the diaphragm are seldom found in the normal position after death. Blows to solid organs have a markedly different effect when delivered in different phases of vascular engorgement. Crushes of the viscera may be severe, with little or no exterior mark. Bursting of overdistended hollow organs may rarely take place, but almost never occur where the organ is not distended. Pinching of delicate structures between a point of application of violence and some firm object, as the spine, may result from pressure or blows, and the violence need not be extreme.

The age of a given injury may be judged, often with considerable accuracy, but the matter requires no little skill, and should be done for practice at the first examination, but the results of the first dozen postmortems should not be spoken of in public, and no feeling of assurance should be allowed to gain possession of one's mind until hundreds of examples have been studied and the conclusions compared with accurate histories.

GUNSHOT WOUNDS

Nowhere is medical literature more crudely at fault than in the discussions regarding gunshot wounds. Without going into these vagaries, we will give a few practical paragraphs on the actual findings.

The effects of the projectile will depend on the sort of weapon from which it is fired, on the powder, and on the character of the projectile itself.

By far the commonest weapon is the pistol or revolver, next comes the shotgun, and last the rifle. Other weapons are seldom used except in war.

The effect on the body will depend on the size of the projectile, its velocity, direction of flight, and the part hit. This includes clothing over the part and structures underneath. The weapon determines what velocity the charge of powder will give to the projectile, as well as the

FIG. 277.—The revolver was fired while held firmly in position. The smoke of the discharge has made a smudge which has a definite shape and extends some distance from the muzzle.

spin of the bullet or the shape of the mass of shot, and the sort of combustion that the powder will undergo. It also may influence the shape of the projectile and always determines its direction. The length of barrel, or combustion tube, will determine somewhat the condition of the gases and residue that follow the projectile.

FIG. 278.—The revolver has been removed and the smudge about the chamber is now clearly seen. This is most marked where the barrel and chamber meet, but extends in a definite way, and would mark any part of the hand held near this space. A large charge of black powder was used.

Pistols formerly commonly, recently rarely, were made to discharge round bullets. Generally they have a revolving block with several separate chambers holding cartridges; between the chamber and the barrel is a space through which gas escapes (see Figs. 277, 278).

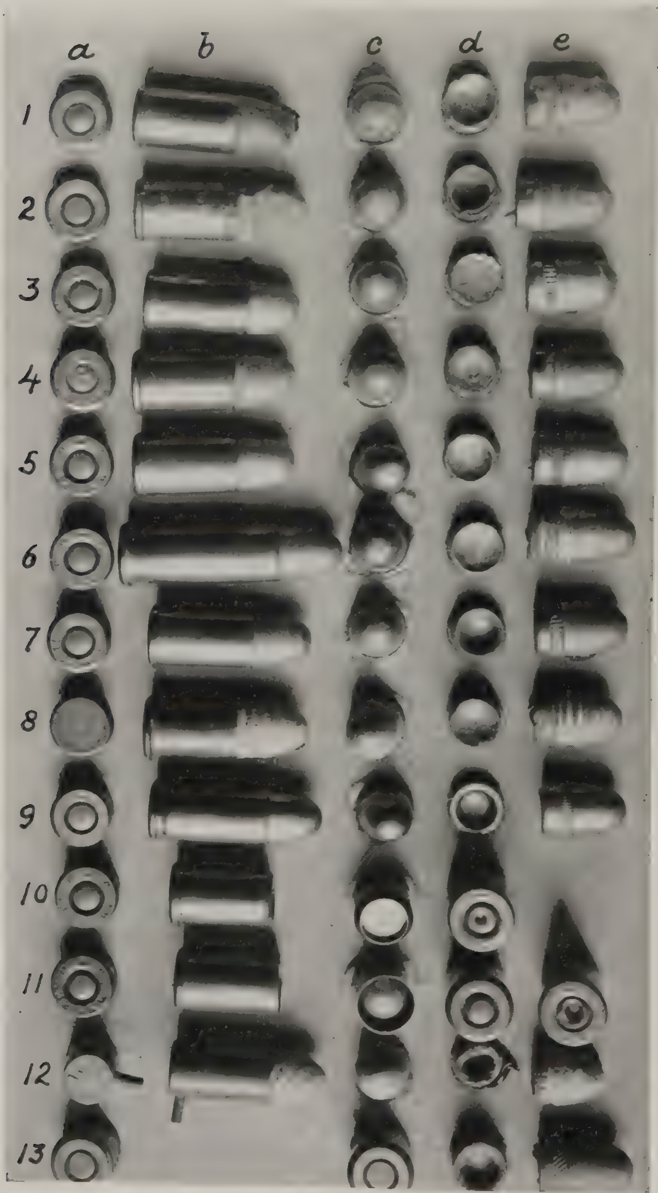


FIG. 279.—"32" CARTRIDGES.

COLLECTION OF "32" CALIBER PISTOL CARTRIDGES AND BULLETS

Figure 279 shows the simple principles of the study of bullets and cartridges of a single caliber. With the exception of 10, *d* and 11, *d* and *e*, which were slipped in, the columns *a*, *b*, *c*, *d*, *e* show respectively the base, the whole cartridge, the bullet nose, its base, and its profile.

Cartridges.—*Bases* are generally expanded so as to prevent the cartridge from slipping into the barrel and to catch or engage the extractor (columns *a* and *b*). On the base is usually stamped the letters or mark of the manufacturer and the caliber. 32 S. & W. means that the cartridge will fit any pistol having the standard size adopted by Smith and Wesson.

Marks of the firing-pin on the cap differ with the pistol (compare 10, *d* and 11, *e*); this is often useful in examining ejected shells. Note size, shape, and position of dent.

Fire is the name given to the manner of arranging the charge of fulminate used to ignite the powder.

Center-fire means that there is a small separate cap which is placed in the center of the base. These *caps* are usually of copper, and contain a tiny anvil, against which the firing-pin or hammer of the pistol drives the bit of fulminate to cause it to explode.

Rim-fire (8) has the fulminate so placed that the hammer strikes on the edge or rim.

Pin-fire (12), an old form, where a brass or copper pin projects on one side of the base, and on being struck by the hammer it is driven against a bit of fulminate on a fixed anvil.

Automatics (9) are center-fire, but they have a notch for the extractor and no projecting rim.

Makes.—The common forms met with in this country are Peters (3); Union Metallic Cartridge Co. (5, 10, 11); Winchester Repeating Arms Co. (7, 9) and H (8); United States Cartridge Co. (4); 1, 2, and 13 are low-grade German makes; 12 is an old form of French make.

Bullets are made of lead (8 and 12), of alloys of lead and tin, or of lead covered with a jacket (9).

The *caliber* is measured at the base of the bullet, and should vary very little for a given lot, but the shape of the nose or front is seen to vary quite a little between the different makes.

Seating or placing in the shell also varies. Some are set well in, while others are lightly set (8, 12); in 11, where a round bullet is used, it is well within the shell.

Lubricant is frequently used. In some (1) the bullet is dipped in a compound like tallow; in 2 the end of the cartridge is dipped. Generally the lubricant is contained in a groove near the base, and is covered by the shell (seen partly removed in 3 and 5). Some have no lubricant (9).

Crimping is the pressing down of the edge of the shell on the seated bullet to hold it fast and to seal the cartridge; this produces a ring in the bullet (1 and 8).

Grooves about the bullet were formerly very common, and are found in rifle bullets still. Generally they are milled, and the character of the milling helps to identify the make: 1 and 13 show diagonal milling; 5 and 6 show fine milling in a wide groove; 9 shows a sharply milled groove used as a crimping place.

Notches appear in 5 and 6 beyond the crimping.

Bases vary from flat (4), slightly cupped (3), moderately cupped (5, 6) to deeply cupped (2, 12, 13). The edge of the cup also varies, compare 1, 2, 6, 9.

Jackets or harder metal capsules into which lead cores are swaged (9) are usually of nickel-plated copper, copper-nickel alloy, or nickel-plated steel. They have the edge turned over the base of the core.

Blanks (10, *a*, *b*, *c*) have a cardboard wad placed over the powder, and the crimp is much greater than when bullets are used.

These characteristics are of far more value than weights, and must be mastered before conclusions are drawn.

This may cause marks on a hand holding the weapon and affects the velocity of the projectile. Automatic pistols are coming into use which are built on a different plan, use smokeless powder, and throw a jacketed bullet. Nearly all modern pistols have spiral "lands and grooves" which cause the bullet to spin; these leave corresponding marks on the bullet, and any changes, such as rust, fouling, or wear, cause

Fig. 280.—Firearms Kit.

An ordinary fishing tackle box, in which are packed ramrods, brushes, hammer, screwdriver with several blades, lenses and holders, forceps, files, dental tools, universal handle, protractors, small flat calipers, bullet micrometer, scales and weights, tubes for specimens, linear measures, emery, oil and "No. 9," rags and cotton. Above are seen fine lead fuse wire for making impressions of bullets; my little contour meter, consisting of a row of pins in a piece of cork, through which they are gently pushed until they touch the surface of the bullet; two cones of cardboard for measuring openings. Below at left is a card with a cut 10 cm. long and from ½ inch in width to a point. Cheap, quickly made, and fairly accurate way of determing the size of a bullet by measuring the distance in millimeters from apex to the point where the bullet touches the edges and dividing by 2.

a modification of such marks. All weapons recoil or kick on the explosion of the powder. This begins immediately and causes a flip or jump of the weapon. It is of importance as an aid in determining the position in which the weapon was held where the muzzle was held close to the part wounded. In ordinary pistols the flip is upward or toward the

hammer, but this is often modified to one or other side by the peculiarity of the holding.

The projectile is seldom round, but generally elongated, and has many peculiarities, depending on the fancy, theory, or ingenuity of the maker. (These are indicated in Fig. 279.) The projectile is supposed to go straight from the muzzle until deflected or stopped.

A small number of bullets, when shot from dirty or worn barrels or if too small for the barrel, tend to turn, and this is not righted if the "rifling" of the barrel is not effective in producing a spinning of the bullet. Such bullets may strike at an angle or even side on instead of point on, thus misleading the observer of the wound. The substance of which most projectiles is made is lead; this is frequently hardened by the addition of tin or other metals, and the practice is growing of covering the lead core with a thin "jacket" of a harder metal, either of copper or alloy, or, rarely, of steel. These bullets remain brighter and smoother and retain their shape better than lead alone. Lead bullets tend to shorten slightly from the impact of the explosion and markedly on striking a resisting object. This change is often effected by clothing outside the body. They also bend more or less on striking at an angle.

Even apparently unresisting tissues may cause changes in the shape of soft bullets, but hard objects, such as bone, produce very marked alterations, even when they pass through such bone readily.

The **powder** is of two general types. The old black gunpowder, which is made of charcoal, sulphur, and niter, gives a very considerable smoke and yields a residue after combusiton. This explodes only and does not burn as do the nitrite powders. The grains are irregular in shape, and may be thrown out to a considerable distance from the muzzle, and, failing to explode, may cause small wounds. The gases which follow the projectile are hot, and may ignite clothing or cause serious wounds because they leave the muzzle at a very high velocity and under great pressure. The residue carried along in these gases causes a sort of sand blast which may denude the skin and cause what is called a smudge.

Smokeless powders are regularly formed as beads or minute tubes or in fine flakes, and they burn like celluloid when ignited, requiring special means to cause them to explode. The marks are quite different from those produced by the unexploded grains of black powder.

Deflection of the projectile before reaching the body is often claimed as a defense, but as such deflection means that the bullet must have glanced from or passed through some object there will be evidence on the bullet to show this.

Deflection by the clothing or by parts of the body, however, is quite common, and one must be careful to distinguish between marks on the projectile received in the body from those made before it reached the body. This requires considerable skill at times, for which it is necessary to have accurate calipers and protractors, and my little contour meter (see Fig. 280).

FIG. 281.—COAT, SHOWING INSIDE. EFFECT OF DISCHARGE OF PISTOL CLOSE TO CLOTHING.

1. Bullet passed through overcoat before it reached this coat; as here seen is a wound of exit. 2. Smudge from muzzle. 3. Similar to 1. 4. Smudge and burn made by the hot gases from the pistol.

FIG. 282.—VEST IN SAME CASE.

1. Same as above, but direction of passage not clear. 2. Smudge and burn from gases of muzzle held very close—pressed against cloth lightly, bullet clearly going in. 3. Same as above except, clearly, bullet was going in. 4. Extensive smudge and burn, muzzle was near the surface of the cloth. Same discharge as 4 in Fig. 281. Note the position of smudges as related to the holes. These four wounds were inflicted by a determined suicide, and the shots were fired in quick succession. (See Fig. 283.)

Effect of Clothing.—A soft lead bullet striking point on against the clothing takes an impression of the cloth which generally remains. This is done while the bullet is pushing inward. The resulting effect on the velocity and direction of the bullet varies greatly, but may be sufficient to wholly arrest the bullet at or in the skin, giving only a bruise to the tissues. Such a bruise will be the result of the blow delivered by the clothing and bullet. Clothing may be carried in with the bullet. Hard objects, such as buttons or jewelry, often add new factors.

The **wound of entrance** generally shows the effect of the clothing as well as of the bullet. The shape of the wound will be round if the bullet hits point on, and more or less elongated if it came in a direction

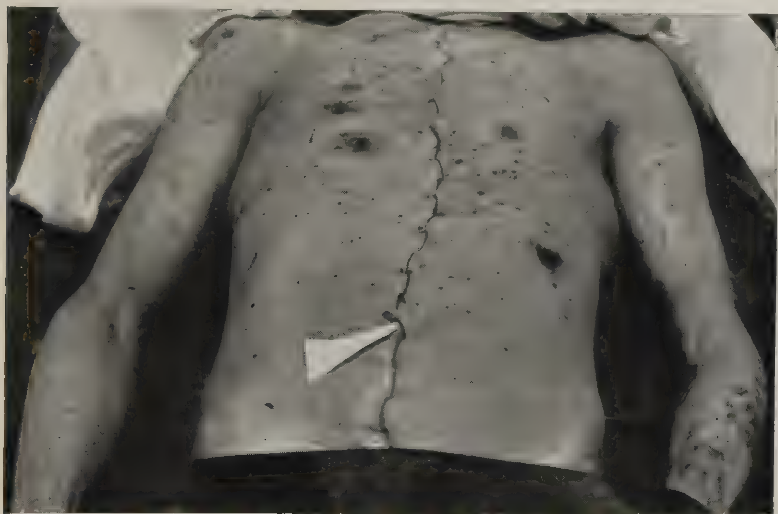


Fig. 283.—Same case as Figs. 281 and 282. The body was sewed up by an attendant before a photographer arrived, so wound 3 is included in the part turned in, but its position is indicated by a strip of paper; 1 is just below the right nipple; 2, still lower; 3, above the umbilicus; 4, at the edge of the ribs on the left side. Note the bruising about the wounds of entrance. This is due to the clothing in front of the bullet. The skin disease had been diagnosed as syphilis at a fake medical institute, and the man was poisoned with mercury and depressed by the methods of the fakes and his fear of syphilis. From the history I am led to believe the eruption was that of psoriasis, and the suicide must be charged against the fake institute.

not perpendicular to the surface. A similar elongation occurs if the bullet was coming perpendicularly to the surface, but was advancing more or less sideways. In case of a markedly slanting wound the side of the wound first touched is apt to be rubbed and bruised and the far side may be like a wound of exit. Size of the wound of entrance should correspond with the projectile, appearing slightly smaller, from the tendency of the tissues to project into the wound, but it will readily admit the same sized bullet with very slight pressure. Such a test should, however, never be made until after the complete examination has been made of the wound, nor should careless probing of a wound be indulged in. Only the gentlest probing is permissible, and then only when it is necessary to determine the direction of the path of the bullet.

The effect of the projectile on the tissues will depend on its size, shape, velocity and direction, and on the nature of the part. It must be remembered that a bullet pushes forward a resistant substance until its

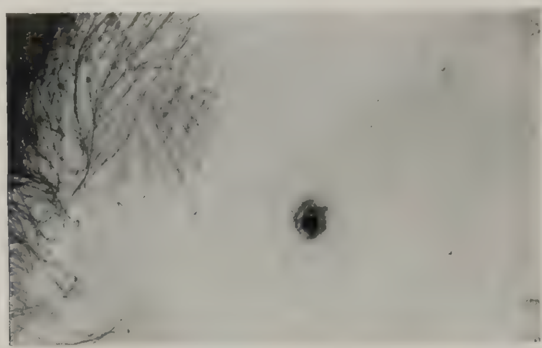


Fig. 284.—A Typical Wound of Entrance Where the Bullet Has Gone Nearly Straight in and There Was Clothing on the Body.

Note the central hole and the narrow ring around it. The hole has an irregular funnel shape. The tissue is somewhat fringed and tends to push out and partly fill up the wound.

limit of elasticity is reached, when it gives way. This accounts for the misinterpretations now so common about the explosive effects of bullets.

Fig. 285.—Four Pistol Wounds of Entrance—Homicidal.

1 and 2 are so close together that the clothing bruises overlap each other; these bullets went directly inward; 3 passed sharply upward; 4 entered at a marked angle, and the skin is scraped by the clothing and bullet for fully an inch before the bullet broke through the combined cloth and skin.

Thus, in wounds of livers which project below the ribs, and when the belly wall bends in readily, we find this so-called explosion, which is nothing but the wound produced by a blow inflicted by an invaginated

belly wall, followed by the penetration of the bullet. The error has arisen through the inability of certain observers to discriminate between a tin can and a liver.

It must be remembered that each structure penetrated has a definite influence on the result, but that result depends on the resultant of all tissues and not of any one. The commonest effect of resistance is to

Fig. 286.—Case of Boy Shot by Playmate Who Used a "22" Rifle.

Very striking picture, showing clearly that the bullet had entered at a considerable angle, produced a hole fracture with radiating linear fractures, and an extensive hemorrhage due to the rebound of the skull against the scalp. The bullet is embedded in the fragments of bone at the back of the head, where there is no hemorrhage in the scalp, as the skull rebounded in the other direction. There was marked hemorrhage about the membranes of the brain at this spot. The anterior flap of scalp also shows the rebound hemorrhage. One seldom sees such a perfect rebound effect. The skull was highly elastic and the position of the wound also favored the result.

tip the bullet over so that it no longer continues point on. This, however, is generally found when the bullet entered at an angle, but in going through the skull this is not necessary, the bullet often tumbling over and over and causing great damage.

The **path** of a bullet is often clearly marked through the tissues, but not rarely, specially in large muscles, it is lost, oftener if the person lives some days after receiving the wound.

In studying wounds near the diaphragm one must always consider the position of that organ at the instant the shot was received. This is so often forgotten by surgeons that I am frequently compelled to report wounds of viscera not diagnosed clinically, even after operation for repair.

Finding the bullet is always desirable, sometimes very important, but at times difficult. An *x*-ray picture may help at times. The bullet may enter the stomach and be vomited—I found one such lodged in the glottis—or may pass by the bowel, or may find its way out and lodge in the clotted blood in the pelvis. Such clot may be cleared out by the

FIG. 287.—DOUBLE HOMICIDAL WOUND OF HEAD.

This is an extremely interesting case. There are two bullet wounds in the right side of the face. One, at close range, shows the powder marks. The other resembles a rip, which it really is; in this the muzzle was pressed firmly against the skin. The gases which follow the bullet spread out under the skin while the bullet was passing through the skull and caused two considerable tears, the one in front of the ear being caused by the resistance offered by the ear to the extension of this gas pocket. The swelling of the upper lid of the left eye is characteristic of serious violence to the wall of the orbit. (Compare with Fig. 288.)

surgeon or the bullet may pass out of the body by a wound of exit. I have frequently found bullets which dropped out of the wound and lodged in the clothing.

One can best look for a difficult bullet by careful scrutiny of parts in the possible direction of the path which would remain open. The serous membranes lining the cavities seldom close after the passage of a medium-sized bullet. The muscles, however, are always troublesome.

Hemorrhages along the path are generally due to concussion of the tissues. In the fascia they generally mislead one because they occur

at a distance from the wound and arise as a result of the massive compression of the parts by the oncoming bullet. Those about the skull, however, are often due to the rebound of the skull after the bullet has passed; this is in addition to the compression effects, which are general.

Infection after wounds by projectiles follows the ordinary laws of penetrating wounds, with the added factors of concussion and hemorrhages along the path. One still hears ignorant chatter about the heat of the bullet doing wonderful things. A clean, well-polished, hard-jacketed bullet will not gather dirt as will a rough, soft, waxed lead

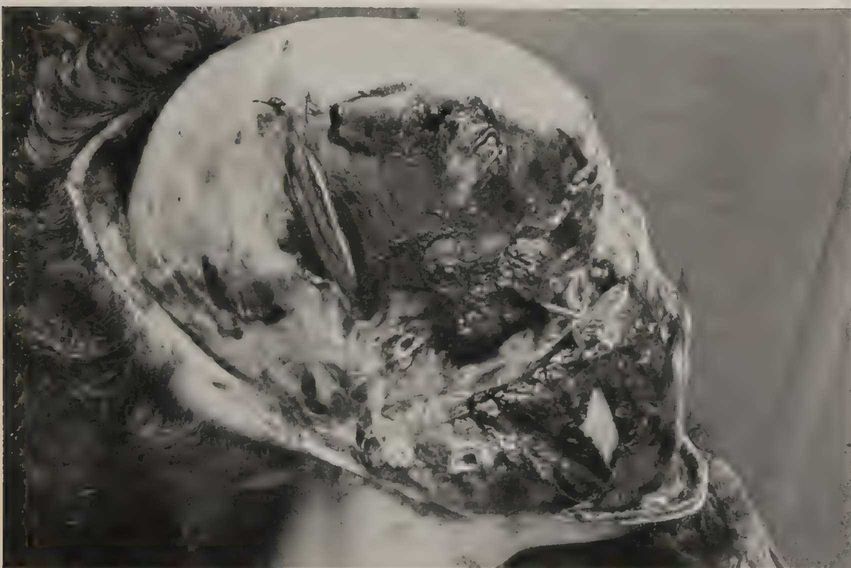


Fig. 288.—The scalp having been reflected, a small probe is seen projecting from the anterior wound. The characteristic hemorrhage due to rebound of the skull is clearly marked in all layers of the scalp. The external auditory meatus has been cut, and both ends are seen in the lower middle part of the plate. Nearly in the center of the hemorrhagic area is seen a circular mark with a hole in the center. This was directly under the large rip and was caused by the hot gases, the bullet passing later through the central hole. All about this area, specially up and back, can be seen the grayish effect produced by the hot gases—it is a combination of smoking and singeing.

bullet, but if it does get infected, the germ will go in unless it is rubbed off the smooth surface, which is a possibility.

The **direction** of a through-and-through wound is often of importance, and it must be remembered that an in-going bullet causes concussion ahead, and the compression preceding penetration modifies the shape of the wound and the effect produced. Where fragments of bone are carried in or driven out, the problem is usually easy, but in the belly such problems are often troublesome. Generally the wound of *exit* is different, because there is no tissue beyond the skin to support it, and the effect often resembles a bursting rather than the typical punched-in effect of the wound of entrance. If the clothing has been

punctured there is generally clear evidence in the way the fringe of torn textile points.

Shotgun wounds may show the wads and are often frightfully lacerated, and may, if at close range, show extensive gas wounds.

Gas wounds occur when the muzzle is pressed against the skin, so that the gas enters the wound after the bullet and then expands. If they occur from blank cartridges the wad will be found in the wound.

Recovered **bullets** should be most carefully handled, carefully cleaned, wrapped, and labeled, and subsequently their peculiarities noted (see Fig. 279).

INSURANCE

The making of postmortems where insurance claims are under discussion has grown to be a recognized branch which demands more than usual skill and understanding. The rapid growth of certain sorts of insurance has increased the importance of this branch. Insurance on lives has grown so enormously during the past century that the business has not yet reached a scientific basis, but it is clearly approaching the period when the necessity for such a basis will be fully realized.

More progress has been made in the mathematic or actuarial phase than in the medical, but the future will show a decided change, because the mathematic mill must have the right data to work up, and as the medical sciences alone can furnish such data, progress must depend on the improvement in quality and increase in amount of such data. While the problems are generally solved by sound common-sense judgment, such judgment cannot proceed without right material to work on. Some very simple but very fundamental principles underlie this group of problems. Every factor of inheritance, development, conditioning, habit, and resultant quality of the individual has a direct bearing on his viability or chance of maintaining life to the limit or period characteristic of his peculiar type or group. Every species of living thing, whether animal or plant, has its period of life.

The human species has a rather variable period, depending on a considerable variation of type. The efforts of those engaged in the study of the problems which underlie the business of life insurance have been chiefly along the line of constructing tables from which to calculate the probable length of life of the individual.

To be able to commence such tables it is necessary to have accurate mortality statistics giving the number of persons of the different ages who die each year, and to compare these with the actual number living of the same ages. As soon as rough lists are made out the mathematicians can begin to calculate what the theory of probabilities indicates will be the average chance each individual has of reaching a given age.

Very early in this study a number of modifying factors are found to be acting in certain classes of cases. These factors have gradually assumed a greater significance and the science of the duration of life has already assumed an independent existence, though it is in its extreme infancy. This branch of "chronobiology" is daily assuming greater im-

portance, not simply in life insurance, where it is the basis of all calculations, but is coming to play a vast part in all social sciences.

The theoretic "average" man is born with a potential viability which will enable him under average conditions to reach a certain age. This initial impulse is so complex that one does not find a satisfactory analysis of it in the literature.

Out of it spring all the phenomena of life, growth, evolution, coordination and harmony of parts, and disintegration.

If it is to be studied, its qualitative peculiarities must be understood and its quantitative elements estimated. We have no direct means of approach to it, therefore we must needs use as indices all the anatomic and physiologic phenomena. The use of height, weight, and the relations of these together (or build) to length of life constitute one of the already advanced problems of life insurance, and incomplete as are the results obtained, they have begun to have great influence on the conceptions of viability.

The tables given under Weights and Measures, taken from the Medical Actuarial investigations, show some extremely interesting and valuable facts, but these demand interpretation from the point of view of the biologist before their full value becomes apparent.

What concerns us at present as students of the findings at postmortems is that other data quite as relevant remain to be studied.

Why a fat boy lives long, but a fat man does not, opens up the whole problem of nutrition on one side and the work of the organs on the other, and incidentally brings to mind that the burden on the organs must be so adjusted as not to destroy their harmony of action.

It will be seen that to no other business are the problems of the biology of the human being so fundamentally important as they are to life insurance.

This is beginning to be dimly grasped by the more advanced minds, and as time goes on this significance will be more fully recognized. The medical man alone is competent to attempt to solve the problems of how the initial impulse or potential is affected by the many influences which tend to prolong or shorten life, and his examinations of the living and of the dead must become of increasing value in this work. The phenomena and signs are indices of processes that result from changes in the potential, either congenital or induced by outside influences, which may be incorporated with the life processes so as to constitute acquired characteristics or disease.

These, however, are but simple illustrations of the fundamental importance of biologic analysis. The operator may be called on to make a postmortem on the body of a person who was examined during life, and, having passed, took out a large policy, but died long before the time when a person of his rating should have died. In such a case the problem may be really difficult. The company may have a most elaborate system for determining what is a good risk, the medical examiner may have faithfully followed that system, but an enormous loss has resulted because something was wrong with the system.

I have examined bodies of persons who had been rejected as bad risks who outlived others accepted as good risks, and the insight I have gained from such cases could have been gained in no other way than by postmortem study—not simply a routine cutting to collect certain data, but a true analysis of the actual conditions and their meaning.

The study is twofold: first, as a biologic entity; second, as a biologically evolved machine of a very complex mechanical construction, capable of maintaining itself under certain conditions.

That this study of the human being as a machine capable of lasting a normal lifetime is barely in its infancy is clear to all who understand both the problems and the business of life insurance.

The future will show a vastly greater interest on the part of the progressive companies in postmortems, and the extension of this method of gathering data on which to form new tables and by which to rationally interpret the results of the examinations made during life.

There is no other way known of testing out the theories on which insurance is either written or withheld after a medical examination than by a systematic study of the postmortem findings in connection with the other records. Every man, whether insurance was granted or refused after being examined, who comes to the postmortem table should interest every person whose business it is to consider the value of risks.

I have examined so many men who had been examined for insurance—some of whom were accepted and some rejected—whose deaths did not occur at the time indicated by the theory of probabilities or the accepted rules as to good and bad risks, that I am convinced that the present rules are based on almost primitive conceptions.

That such variations tend to equalize each other in a large series of cases should not mislead the thoughtful person as to their significance.

Certain very expert examiners display a truly remarkable grasp of the essentials of the problems of human viability, but it is interesting to think how much more they would know and how much oftener they would escape those errors which even the most expert are prone to make if there was a larger use of the wisdom to be gained alone by postmortem examinations. This intelligent use of the data obtained at such examinations will grow gradually because business managers are apt to be impatient if they do not find immediate and large gains, but no big business can long resist the modern tendency to introduce scientific methods, because they are found to pay in the end.

At present the companies do not care to pay for such examinations unless they believe they should contest a claim.

The result is that their attitude tends to make the public more reluctant to have such postmortems made, and the gathering of desirable data is thus hindered, though it is of vital importance to the big stable companies to have such data.

It would be well if the companies would organize a table of "things to be observed" both in life and at the postmortem, looking to future progress in this matter.

In contested claims, when large amounts are involved, the agent who

wrote the insurance is apt to oppose such investigations as may tend to reduce his receipts or discredit his methods.

Many persons make false statements in applying for insurance and this falseness tends to invalidate any claim.

The medical examiner is supposed to be alert to detect such misstatements by the various examinations he makes, and also to discover what the applicant may have been honestly ignorant of.

One falsely procured insurance for a large sum detected by the post-mortem examination would pay for a great many examinations and give a vast amount of valuable data besides, which would be clear profit to the companies. The discovery of a lesion that must have existed and given marked symptoms before the application was filed is conclusive proof of intent to defraud.

The high standard of honor among the better companies has been largely the result of the need they recognize of having a reputation for fair dealing, and this makes it possible for the honorable expert to work for such companies without fear of being urged or influenced to do what is wrong.

This naturally tends to bring forward honest experts, and gives a legitimate opportunity for profitable employment for a limited number of such persons.

A personal knowledge of the gradual increase of this work has induced me to enter on this rather extended discussion of the subject.

The problems which specially deserve attention are apt to be but indifferently treated of in works on pathology and general medicine. They consist so largely of the relation of the condition of parts of the body to the health of the whole that they belong almost entirely to the field of physiology, with so much of that part which treats of the change of function and structure by physiologic reaction and readjustment as forms the whole basis of pathogenesis. The gradualness of such changes brings in a consideration of the time it takes to produce conditions, which is as yet an undeveloped part of the medical sciences. What has been already said about the relation of the various findings and the influence of parts on other parts and on the whole will, on careful thought, be seen to have direct bearing on this type of study.

Accident and **industrial** insurance work demands the most thorough knowledge of the effects of all sorts of injuries on the organs and tissues. It is not sufficient to be able to dissect well and describe clearly what is seen, though these are essential as a foundation, but one must know how to investigate the condition which is present or supposed. The mass of the work will consist of conclusions rightly drawn regarding the functions of the various parts of the body, because it is obviously impossible to determine what variation of function followed disturbances unless we have clear and true knowledge of how the parts would act normally, and also how they would act in the condition in which we find them, aside from the immediate results of the injury from an anatomic point of view.

This study of the abnormal action of abnormal parts may be called pathologic physiology, and constitutes a very large part of the work of the person who would properly estimate the effect produced by injury on normal or diseased bodies that he is called on to examine.

The influence of violence on normal tissue is considered under Wounds.

In most accident insurance one is concerned only with those forms of injury which clearly cause fatal results from their nature rather than from some remote influence they may have on some older disease. Juries, however, are often pleased to look with complacency on attempts to rob corporations which handle large amounts of money, and the fact of an injury and a death soon afterward is apt to arouse a suspicion that the company is trying to avoid its obligations. It is, therefore, necessary in these cases to be specially careful to observe fully as well as accurately all those things which are pertinent to the problem, and to think actively and clearly so as to know what to observe and how to investigate, as well as how to state concisely but forcibly what was seen, and what significance should be attached to the findings. These general suggestions apply equally, whether one is hired by the State, by the individual who is making a claim, or by the company.

In all cases where questions of contract for insurance may be involved, one must be careful to have proper authority for making the examination.

If the company has inserted a clause in the contract by which the right to make the postmortem is reserved, this may be waived only by the consent of their representative, but does not in any way affect the properly authorized officer of the State.

The identity of the body must be proved. The number of persons present and their right to be present must be adjusted by amicable arrangement or by appeal to the rule of equal representation of each side interested. So far as possible only competent and discrete persons should be in attendance.

The tendency of mere pathologists to waste time over irrelevant matters should be suppressed, at least until the important investigation has been concluded, then it may be just as well to allow others to extend the examination. I have in this way often been enabled to discover the essentials overlooked by the operator, and I have seen a trouble-making person so satisfactorily display his total incompetence for this sort of work that he was no longer the source of danger which he might have been had he simply confined himself to denying the facts he failed to observe or understand, through gross ignorance.

Industrial insurance is largely a modified form of accident indemnity, but it contains an element not usually included in that form, namely, that of slowly acting processes or poisons which are deleterious or destructive to the health or life of the individual. Anything in an industry that harms the worker, whether it be bad air, dust, gases, poisons or injury, or simply causes exhaustion or malformation resulting from continuously performing certain tasks, may be the grounds for

a claim for compensation. Though the form of insurance written may not cover all these, the tendency of modern times is to include them.

It will be seen that this form of insurance is a modified life policy, though we are dealing with what life insurance companies usually refuse, as risks not to be accepted. The problems of suddenly produced effects are those of accident work, but those which result more gradually and as the sequelæ of the continuous action or of frequently repeated acts introduce the whole field of pathogenesis, even to that which is related to infections, because any disease, disorder, deformity, or disability acquired in the performance of duty, even to the predisposition to such conditions, is part of the possibility of a given case.

ELECTRICITY

The frequency of electrically produced injuries and death and the singularly erratic conceptions held by practical electricians on the action of currents of electricity on the body, coupled with the unsatisfactory

FIG. 289.—SLIGHT CONTRACTION OF RIGHT HAND.

It also shows the peculiar mottling not rarely noted. "Goose-flesh" was well marked. Death was due to spasm asphyxia by fixation of the respiratory muscles. The current entering by the right hand, leaving by the feet.

discussions in the available literature, have induced me to add this brief résumé of the subject. In ordinary industrial currents it is necessary for the body to come in contact with some conductor. In lightning or in very high-tension currents such contact is not usually made, and the effects are often produced by induction phenomena, but occasionally by the passage of the discharge through the body. The effects of disruptive discharges are rarely seen, but those from industrial currents are common. The most important factor is the resistance of the skin, which forms a true insulator, though of very variable thickness and resisting power.

The assurance which develops in the minds of persons who work about electric apparatus is often surprising and not infrequently leads to fatal accidents. This assurance results from various experiences with currents that have entered the body when and where the skin was resistant.

It is stated in various publications that the human body has a high resistance, and various measures of resistance are given, nearly all of which are misleading. Dry skin, specially the thick skin of the palm of the hand, is very resistant, but if that skin is wet the resistance rapidly

Fig. 290.—A Typical Case of Severe Effect.

Several separate contacts were made with wires of rather high voltage. There was general intense rigidity with contraction; the right hand moderately bent (see also Fig. 291); the left hand still contractured after having been forcibly tied to a board for Fig. 292 for some minutes. Note also the position of the feet.

falls, and if some electrolite, such as salt or metallic compounds, be added to the water with which the skin is soaked (for mere surface moisture is not enough), then the resistance falls quickly.

I have tested certain persons who boasted about their great power to

resist electricity with moist electrodes applied to selected areas of the skin, when the power to resist disappeared almost entirely. An oily skin which resists wetting may block the current even with a moist electrode. Persons with thin skin and little natural oil, and those with a tendency to perspire easily, show great sensitiveness to low currents. There is, of course, a moderate degree of variation among different individuals in regard to the effect produced by the same strength of current, but by far the greatest difference lies in the insulation of the surface.

Given a suitable condition of skin, either oil free, water soaked, very thin and vascular, with but little insulation or some denudation or

Fig. 291 is the right hand, showing a burn on the wrist of moderate severity.

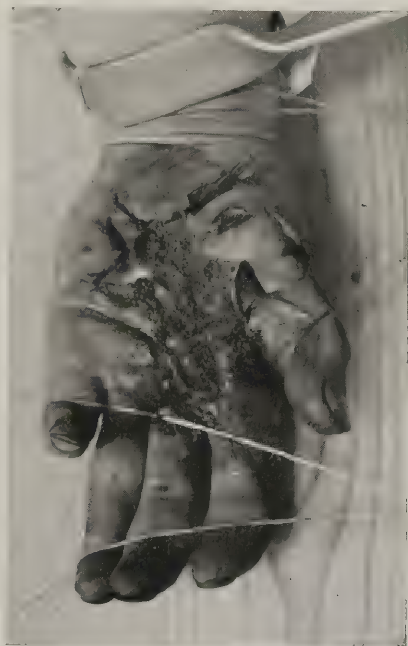


Fig. 292 is the left hand, showing very severe burn, with charring of tissues and extreme contraction, which is only partly overcome, though considerable force was used. Note the tendency of the outer skin to separate.

wound, and very low currents will enter the body. Generally in serious cases there will be found two points of contact, where the current enters and where it leaves the body, though this double contact is not absolutely necessary when the current is of high tension or is of the alternating variety.

The passage of the current through the tissues may be by a single path, or by several routes, in which case the amount of current going over any route will vary with the conditions, or the current may diffuse itself widely. Normally, the current finds easy paths, and the blood-vesels and nerves constitute those commonly selected. The large veins

usually are excellent conductors, and these lead the current naturally to the heart, where serious effects are often produced. This is probably one reason why so many electrocutions by low currents are recorded as due to heart disease.

The tension of the current is measured by volts, and the question often arises as to the voltage necessary to enter the body. I have seen a delicate woman receive a shock from a 110-volt incandescent light socket by a single contact, with no possible grounding, which produced the most painful neuritis of the whole arm that lasted for months, and a slight burn of the fingers from arcing which was slow to heal because of

Fig. 293.—Multiple Contacts.

One contact on right hand with contraction and severe burn. Over buttocks the other contact was made, at many points, by disruptive discharges. The burned areas are due to the underclothing being set on fire and are not electric lesions; "goose-flesh" was marked. (Courtesy of Mr. H. B. Harmer.)

the trophic disturbance caused by the injury to the nerves. I have also examined cases where a similar current had caused death. In such cases there is generally a good grounding or second contact. There is no doubt that lower voltage currents can produce fatal results under unusually good contact conditions.

The volume, or amperage, of the current passing into the body is of importance in all cases, but specially when the effect produced is in the nature of electrolysis, either of the blood or of other tissues, but when the effect is simply the production of muscular spasm the tetanizing property of the current is the chief factor.

The effects produced in the body may be grouped for convenience into—

(1) **Muscular Effects.**—These are contractions, and take place by direct action on the muscle or by nerve excitations, and they may be local, extended, or general. When the local area includes the muscles of respiration we have asphyxia, which may be fatal in a very short time. Not infrequently the heart is directly affected, and in my experience this organ has generally been stopped in systole. When such heart effect is produced it may cause almost instant death, but this result usually requires at least a short period of time in order to fix the heart and do it such damage as to prevent its recovery. If the heart is below normal such injury may not need to be very great.

FIG. 294.—DIFFERENT TYPE OF BURN, WHERE THE CURRENT HAD PASSED THROUGH THE SHOES.

In the left heel the current passed from a nail. In the toes the current went through wet leather. (Courtesy of Mr. H. B. Harmer.)

(2) **General Spasm.**—This is brought about by direct nervous excitation, and is noted in its onset as a more or less orderly effect, such as is seen when a man jumps so forcibly as to appear to be thrown. Such violent spasms often save the life of the individual by breaking the contact before electrolysis can advance far.

(3) The **effects on the heart,** already mentioned, are probably partly due to nervous and partly to muscular excitation, but whatever the right theory of action may be, the results are not in doubt.

(4) **Electrolytic Effects.**—The passage of the current produces actual chemical changes in the tissues which can best be classed as electrolytic, though there are other changes that are not properly so described.

It is possible that a part of what appears to be due to electrolytic action may be due to some other action for which there is no adequate name. The phenomena noted are gas production, blood disorganization, color changes, texture changes, coagulations.

(5) **Nervous Effects.**—Direct stimulation, as seen by muscular actions and sensations, is common; actual destruction of function, which appears to depend on tissue changes and suggests electrolysis, finally shock, loss of consciousness, and death. There are found in the brains of persons who have had strong currents through the head evidences of gas production in the small vessels and, in extreme cases, evident disruptive discharges are shown. In most cases the nervous effects are marked.

FIG. 295.—EFFECTS ON UNDERCLOTHING.
Above are seen a number of small punctures and some have burned edges. At the right another group. There were a number of contact points.

(6) **Special muscular phenomena** are to be noted after death. Sometimes "goose-flesh" is quite marked; generally there is marked rigidity of the affected parts. This appears to be local. I remember one case where the current passed through a segment of the spine and rigor was marked only in the back and legs. If there was much heat generated by the current we will find actual coagulation in the affected area.

(7) The **blood** shows certain changes, both under the microscope and to the naked eye, aside from the color that is found in asphyxia. The red cells are markedly changed and the general appearance of the blood is as if soot had been mixed with it. Sometimes its coagulability is reduced. Usually it absorbs oxygen when spread in thin layers, but I

have seen cases where this property was markedly reduced; in such cases the powdery, sooty look was very marked.

(8) **Actual burns** are not produced by the electricity, but by the heat of the discharge. These are often extensive when powerful currents have caused large arcs. Such burns are generally found when the current was of high tension and show the action of great heat. It should be remembered that such burns do not show actual contact with the conductor, but a slight gap across which the sparks leap.

(9) **Disruptive Discharges.**—A current may pierce tissue as it does a piece of paper, leaving small holes, or there may be large holes if the discharge was great. In lightning we find such evidences of disruption taking on a great variety of forms. It is often important to observe evidence of such disruptive discharge in skin and clothing. In the body such paths are occasionally found.

POISONS

The subject of poisons is one which offers peculiar difficulties from every point of view. Everywhere we are confronted with the limitations of knowledge and with an abundance of theories, often made with great disregard of these limitations. The results obtained by poor observers are quite as likely to form the basis for the conclusions offered to us in the literature as are the true estimates of better observers.

Little can be done in a small section with such a subject, but the need of help in this field is felt by all who have to consider cases of poisoning at the postmortem.

A poison is a substance which produces deleterious effects in living tissues by chemical means. From the point of view of the law one must add—and is capable of producing death. Formerly various misconceptions existed as to the time within which such fatal termination should take place; and the amount necessary to cause death had to be some more or less arbitrarily fixed small quantity. Substances are to be labeled "poison" in accordance to such conception of the power of the substance. The term "poison" is often applied only to such substances as are very poisonous. These various uses of the term have caused some to prefer the term "toxic substance," but the advantage gained is not very great. As our understanding of toxicology increases, and we learn more about what poisons are and how they act, we find use for all the words already in use and wish for others. I prefer, therefore, to retain the general term "poison."

The recent growth of pharmacology has to a considerable degree lessened the use of the term "toxicology," while pharmacology is inclusive and broadly covers the field of toxicology, the two sciences have just as much right to exist separately as biology and zoölogy, or as morphology and physiology have to be considered apart from biology. Toxicology rests on three well-recognized subdivisions of science—chemistry, biochemistry, and physiology—for the poison acts by reason of its chemical nature as a chemical substance on the substances in the organ-

ism, and produces changes not only in those substances, but results that are not chemical in type.

The essential conditions for such action are contact and affinity, the result is reaction. Contact is often brought about by solution, but this is not necessary, and we are now gradually coming to understand why this is so as we study how ions behave.

Affinity is a convenient term to cover all those forces which are resident in the poison and in the affected substance which bring about the chemical changes we find taking place. The affinity may be for the substance as a whole, then we have adhesion, absorption, ingestion; or for a part of the substance, then we have some form of true chemical union with more or less fixation of the substances which thus become united. Such resulting substances may be made up of parts of each of the original substances, or of all of one with part of the other, or both may become united as a new compound. After contact and such more or less complete union of substances we note reactions. First, these consist of chemical changes, that is, certain new compounds which have different chemical and physical properties. Then we find that biologic changes appear. These biologic changes are due to the presence of the new substances and to the loss of pre-existing substances which joined to form the new compounds. Such union may take place in the cell substance by inward migration of the toxic substance, or by outward migration of some part of the cell substance, in which case the new compound will be extracellular.

These new compounds then proceed to do things according to their peculiar properties. It is one of the gravest errors of toxicologic discussion to neglect the intermediate steps whereby the original poison is transformed, often a number of times, before it reaches the stage in which it finally acts. Comparatively few of the inorganic poisons remain unchanged, while many of the organic poisons entirely disappear in the body. The biologic reaction is the result of all the chemical changes and their effects on the tissues of the body.

The effect of a poison depends in part on the toxic substances of which it is composed and in part on the way it is put together. Take as an illustration carbon, which as an element appears entirely harmless, combine it with another apparently harmless element, nitrogen, and we have one of the most violent poisons known. Combine it with another supposedly harmless element, oxygen, as carbonic oxid, and we have another violent poison. Now combine oxygen and nitrogen, and we have other poisons. Again, take oxygen and hydrogen in the form of water, and we find a harmless compound without which no life can exist, but combine carbon with hydrogen, and we have a series of the most serious poisons.

We see, therefore, that carbon is the basis of a number of the most violent poisons known. It is, in fact, the most poisonous element we know, and it is easy to see why this is so if we remember the principle of affinity, for most compounds in the body are built up about the carbon nucleus, therefore they and carbon have an affinity for each

other, provided carbon is in a loose combination. The outside carbon tends to share with the carbon within, those more loosely attached groups of associates, and so destroys the complex structures we call the organic molecules of the body. The plant takes in this outside carbon and uses it, and out of it makes both food and poison for the animals. The animal takes in this complex carbon compound as food when the destructive power is suitably neutralized by oxygen and hydrogen.

I have gone into these simple and elemental processes because they are the type on which toxicologic processes are built.

Where metals form firmly fixed compounds they are not poisonous, but when they form easily broken-down compounds they show their innate toxicity just as carbon does. The haloids—bromin, chlorin, etc.—form similar types, but bromin forms less stable compounds than chlorin and is more generally toxic.

We hear about the toxicity of the ions of various elements, as though that was the major part of the subject instead of only the beginning of the discussion, but all the modern chemistry and therapeutics of the organic compounds of these elements tend to show the fallacy of such conclusions. Another fallacy is that regarding the relation of solubility and toxicity, which is, however, rapidly fading under the modern researches regarding ions and their modes of action. Soluble compounds are more toxic because they permit enormously better contact. Poisons enter the body at all points, though naturally at different rates in different parts, and with different degrees of facility because of the physical and chemical conditions of the different parts. Here, again, the question of contact is the most important.

The example of the absorption of ether through the mucous membranes illustrates the principle of extent of contact. Carbolic acid in concentrated solutions enters rapidly through any tissue it has access to. Vapors and gases naturally find the easiest entrance through the lungs. Liquids through the mucous membranes or denuded areas of skin. Insoluble substances must touch nearly naked cells in order to get thorough contact. Absorption of poisons, however, is more complicated, because contact and affinity produce changes and new substances which are more or less easily taken up than the substance applied.

Further changes occur by reason of contact and affinity between secreted or excreted substances and the poisons. The best recognized of these changes is that between the hydrochloric acid in the gastric juice and various substances whereby chlorids are formed. There are many other reactions less well known.

Absorption depends on concentration of the solution or the amount of the insoluble substance present, according to the principle of contact, but this is modified where increase in concentration is detrimental to the absorbing cells, thereby reducing their absorbing power.

Absorption also takes place, to a certain degree at least, by simple physical processes, though this is greatly overestimated at present. Absorption is often delayed by the presence of impermeable mucus; this is a very important factor in all cases where such mucus is present.

The form in which a poison exists in the body depends upon the relative affinities of the substances of which it is made up, and those of the tissues, including the blood, with which it has come in contact. Certain substances appear not to be subject to any entangling alliances, while others entirely lose their characteristics.

The halogens show little tendency to form permanent organic compounds in the body, while many metals show a tendency to become fixed as organic compounds, generally to the detriment of the tissues in which they lodge.

Hydrogen plays a very interesting rôle, for all substances containing loosely held hydrogen are destructive, acting chiefly at the point of entrance, where they are rapidly changed.

In many compounds there are radicles, or groups, which may be considered as elements, in that these radicles are not broken up in the body.

Poisons after entering the organism show special affinity for the substances contained in certain tissues. On this principle rests all specific therapeutics and much of toxicology.

What the effect on the tissues is in each case is at present hardly suspected, and as a result we are compelled to confess that the characteristic lesions produced by most poisons are at present unknown.

We do know much about the "physiologic" action of poisons, that is, what functions are disturbed and how they are changed. From this knowledge of the selective action of substances and their path of elimination we can build up a very considerable mass of toxicologic material and no little insight.

We are not to depend, as was formerly too generally done, on collections of accounts of postmortems on persons who had died from the particular poisons, for our basis from which we are to proceed in any suspected case of poisoning. If we have grounds for suspecting that a certain poison has had anything to do with the cause of death in a particular case, we begin by considering what that poison really is and what it is capable of doing in the human body, and what will remain to be observed of such action after death. Then we consider what variations commonly occur in these findings and why they occur, also what other causes may give rise to similar findings. Not until we have gone through this rather laborious process are we ready to open the body.

The opening of the body is only to confirm or disprove the carefully thought out and built up picture, and to show why unexpected variations have occurred as the result of special bodily conditions.

The reason why we must do our thinking before cutting is very simple —it is because we will destroy our evidence before we realize enough of the case to properly observe it, and if there was a poison we will have to prepare for a chemical examination, which cannot be nearly so well carried out after a general examination as if it has been properly planned beforehand. Add to these considerations the difficulty of carrying all the details of all the poisons in one's superficial or readily accessible memory; also that many of the findings are evanescent and must be understood on sight.

My own rather large experience in this field has confirmed me in this practice of doing all the thinking and remembering and rereading I can before I cut a suspected case of poisoning.

Perhaps an example of the difficulties to be met will not be amiss. A physician reported a case of death from ptomain poisoning. The symptoms were obscure, but not typical. Other persons in the house, still very sick, were closely questioned. One had developed coma and partial paralysis with great depression, another had pains and a metallic taste before violent vomiting; all had vomited and purged.

The only article of food that could have been in doubt was a can of asparagus. The can was corroded. A provisional diagnosis of tin-poisoning was made; a similar can was procured and nearly 4 grains of tin recovered from the contents. The body of the dead man was opened and the stomach contents saved, but he had died from coal-gas poisoning. Tin, however, was recovered from the stomach contents. He had been taken violently ill from tin-poisoning and had gone to sleep in a closed room connected with a faulty heater. Had he not been poisoned by tin he would have gone home and escaped the gas.

It would have been easier to accept the prevalent but utterly unfounded belief that tin-poisoning is of no importance.

This case illustrates the value of careful study of the history, of a knowledge of the action of poisons of all sorts, and of the findings at postmortem, for of the three poisons considered one entered the discussion only through ignorance of symptoms, but the other two were actually present after death. We not rarely find mixed poisonings, and this is the more common since many drugs are given in sufficiently large amounts to give the symptoms and findings which may result from their exhibition.

The effects, as already pointed out, are varied by the manner and rate of absorption, the changes that occur on absorption, and the degree of concentration. Whether there are to be local or general, or both local and general results will depend on whether the poisons are changed on entering and on the violence of the action at the surface of first contact.

Such violent action causes reaction in or destruction of the local tissues, and, of course, the evidence of this is found at the examination. It should be remembered that, while such reaction in a general way indicates the kind and concentration of the poison, it is not a safe guide in judging of the amount present or absorbed, and that that which is still in the stomach or intestines is probably only a part of what was taken. It should also be remembered that poisons are eliminated by the whole alimentary canal, so that a part of what is found there may have caused symptoms before having been eliminated.

Also, one must not forget that poisons fixed in the tissues may or may not be in an active condition.

The matter of elimination has been studied with much care, and there is a large amount of available literature. Unfortunately, it is not all useful, owing to differences of results and opinions. We are greatly in need of a treatise on poisons where, by profound investigation and large

experience, these discords will be reduced and the principles underlying the whole process being first presented and then the types of findings simplified. We can at this time only point out the fact that all tissues throw off certain poisons after they reach a certain concentration. Some tissues are markedly active in this work. It appears that all the secreting structures of the body show this eliminative power, so that every secretion has its possible poison content.

The kidneys show a wide variation in their action, which depends on the degree of concentration, the particular poison, and the special compound of that poison.

The process of elimination may be simply a form of excretion with little effect, but it is very likely to be far more serious, and what is thrown off is often some of the cell substance in combination with the poison. Thus, albuminoid compounds are often found in the urine after poisoning, and too little attention has been paid to the composition of these bodies in such cases.

The metals which form more or less insoluble sulphids tend to pass out into the gut. In the gut the eliminated poison is still capable of causing further poisoning.

The irritations found in the gut from other sources are so common that one should remember that not 1 per cent. of such irritated conditions are the result of what are ordinarily considered as poisons, and that the mustard-water or other treatment is more likely to cause profound irritation than most of the poisons for which such substances are given. It requires extreme care to avoid false conclusions.

The irritations of different drugs differ greatly in kind. Thus, permanganate of potash will produce intense edema of the mucous membrane. In carbolic acid cases the appearance will vary from pale red to very dark red purple, or an entirely white false membranous appearance. Destructive acids or alkalies cause softening and decomposition of the tissues resembling ordinary postmortem digestion, with at times edema. Mustard and similar irritant substances produce a general red blush, which often remains after death.

Of the vast list of easily accessible poisons, there are very few which give clearly marked characteristic signs at the postmortem. The discovery of poisons is usually made by the expert from finding something just a little peculiar—often this is extremely indefinite and impossible to describe. Thus, I once made the diagnosis of opium from the facial expression; at another time, of cocain, from a peculiar condition of the nasal mucous membrane; at another time, of arsenic, from the appearance of the muscles. In each case the diagnosis was amply confirmed.

Nowhere is one required to be so alert as in the study of poisons; nowhere are the histologic findings more worthless; nowhere is one more oppressed by the sense of our general ignorance. Even the chemists fail us in the majority of poisons. Clinicians are more apt to mislead than to help us. In most of the cases referred to me as due to poisons the diagnoses have not been confirmed; many of the cases found to be poisonings were not so reported to me. In very few cases where the

clinical history on which to make the diagnosis was not obtainable was the true poison even suspected before the examination. It is impossible to do expert work in this field on the basis of available text-books or teachings of professional toxicologists alone. The conclusion of the whole matter, then, is for the average practitioner not to attempt to assume the rôle of toxicologic expert, and if one is forced to investigate cases of suspected poisoning let him delay the cutting a few hours until he can obtain every scrap of history, review the pharmacology of the group to which the suspected poison belongs, and assure himself that he has in mind all the other conditions which will produce the effects attributed to the special group, and then let him make the examination under as favorable conditions for careful and thoughtful study as possible, and, incidentally, have the arrangements all completed for the retention of parts for chemical examination. If possible, the chemist should be present to assist, but not direct, unless he should be one of those rare superchemists who are practical toxicologists; then he may be asked to supervise.

As a preparation for a knowledge of toxicology there is nothing better than the study of the treatment sheets in all cases before the postmortem with a careful comparison of the findings with the drugs there listed. It may help, to remember that most poisons act more severely on young persons, and that, while tolerance is not measured by the general health, power to recover is largely affected by the bodily condition.

The types of poisons had better be formed from the selective action they show for special tissues than on laboratory chemistry. Thus, those which produce nerve symptoms belong to several groups, all of which are important; those which produce blood changes (most of the carbon poisons do this); the gastro-enteric and nephritic and hepatic groups, and a few that disturb respiration; with this, of course, goes the question of the degree of saturation of the given tissue.

It is necessary after determining the presence of poison, and often desirable as part of the preliminary investigation, to consider the source of the poison. Children often obtain poisons that are within their reach, commonly such as are used for household purposes or medicine. Adults often procure them where they are employed or absorb them in their occupation. Foods, either through adulteration or being kept in improper vessels, or from coming in contact with substances used in cleaning, which are often very dangerous. Insect destroyers give rise to many cases. Disinfectants are used by suicides frequently, and many accidents arise through carelessness. Cosmetics still cause a few poisonings. Gases from fires or from defective apparatus, or by accident or intent, and gas left turned on, cause vast numbers of deaths, and more chronic and acute poisonings not immediately fatal. Medicines that have evaporated or settled, or that have been wrongly compounded, or that should not have been given, or which are taken in overdose or by mistake, furnish a constant though limited number of cases.

Chemical examinations of tissues or the contents of organs require special technic that is not usually possessed by the medical examiner; nor should it be expected of him, but a special expert should be engaged.

In small towns or rural districts one cannot find a properly equipped chemical laboratory except under very unusual conditions; it is, therefore, better to have an understanding with some chemist of known ability. Such an arrangement should be entered into with the consent of the district attorney and such other local authorities as may have their fingers on the public purse, and should consist in an agreement for preliminary tests which will determine the nature or presence of the substance, and another agreement as to what means shall be used in procuring and transmitting material, and a still further agreement about the completion of the analysis for court purposes.

The general public has little or no idea of the amount or quality of work demanded of the chemist in such cases, and it is not unusual for ignorant persons, such as are frequently the legal powers of a town, to imagine that chemical work is some sort of simple magic requiring little time or effort.

The material which is to go to the laboratory should be collected with the greatest care, so that no foreign matter shall contaminate it. It is placed in new, clean glass jars that have been kept under secure locks. The types of jars best suited for this work are shown in the figures under Technic. The material is placed in the jars by the operator and the jar is closed at once and fastened.

My own practice is to have them placed in front of me, so that I can keep them in view while operating both before and after they are filled. Then they are carefully packed in cases so as not to be broken, taken to the laboratory, where they are delivered to the chemist, or sealed and labeled and placed in an ice-chest with a good lock. If it is necessary to retain them for any time before delivering them to the chemist care should be taken to avoid the bursting of the jars by decomposition. This may be avoided by loosening the covers carefully, by keeping plenty of ice in another part of the chest, or by the use of some chemically pure preservative approved of by the chemist, and a portion of this fluid is retained for test by him. If the suspected poison is volatile the jars cannot be left unfastened, even enough to prevent their bursting, so that the delivery to the chemist must be made at once and his tests must begin as soon as possible.

Certain precautions are desirable as a matter of technic. A lot of clean basins, with water about which no question can be raised, a lot of clean towels, new gloves, freshly scrubbed instruments rolled in clean paper or cloth, and such arrangements for transportation as are necessary both too and from the place where the examination is to be made. The employment of assistants should only be permitted after their ability is ascertained. Helpers about the place must be kept at a distance unless they are properly qualified assistants, and if other persons are entitled to be present they are not to be permitted to endanger the results of the proceedings.

The whole proceeding should be conducted with technic resembling a surgical operation in a clinic.

PART VI

PHOTOGRAPHS

The difficulties I had to overcome in preparing the figures for this book, and the inability to find in any one place an adequate explanation of the fundamental principles of the art as applied to postmortem work, coupled with the enthusiastic appreciation of the results I obtained, received from anatomists, surgeons, pathologists, and professional photographers, and being convinced of the great practical value of this method of retaining records of findings, it seemed to the publishers and myself quite proper to include this section.

That we were not in error in this matter is shown by the fact that, following a visit by a member of the staff, my methods were adopted in the largest private clinic in this country.

That the photographic method will become more widely used in the laboratory, clinic, and postmortem room is more than a hope, because it is the only method consistant with progress. The day of crude, clumsy, spasmodic, unstudied photographic attempts has passed. The art must be studied and adapted to the work which is of a special sort, and cannot be taken up at a moment's notice, even by one fairly familiar with lenses, cameras, plates, lighting, screen work, exposure, development, and printing.

The photographs in this book were taken under every imaginable sort of difficulty with an old camera; in all sorts of places; with all sorts of lights, and not a single convenience, for there is not a postmortem room in this city fitted for the taking of photographs.

A few paragraphs on how to overcome difficulties will at least have a basis in experience:

(1) *The Camera.*—Thirty years ago while at school I took pictures, with a sixteen-dollar outfit, that I would be willing to have compared with some that take prizes today. The price should not, therefore, be an obstacle. If one can afford an elaborate outfit, with rapid high-class lenses and fancy devices, all the better. A moderately wide-angled lens is the best for this sort of work, but too wide an angle gives distortion. The chief advantage of a rapid lens is that it saves time. At times soft tissues settle during long exposures, so that speed is often necessary. The form of the camera is purely a matter of personal choice beyond the essentials of a fairly long bellows, swing back, and firmness of construction. I prefer a revolving back, as 5 by 7 inch plates can be used, while larger ones are needed if a fixed back is used.

The pictures show several devices for use in tilting the camera.

For rough quick work a stout folding camera tripod is necessary, with the tip top shown in Fig. 296; for clinics or laboratories specially constructed holders are desirable, but these need not be expensive.

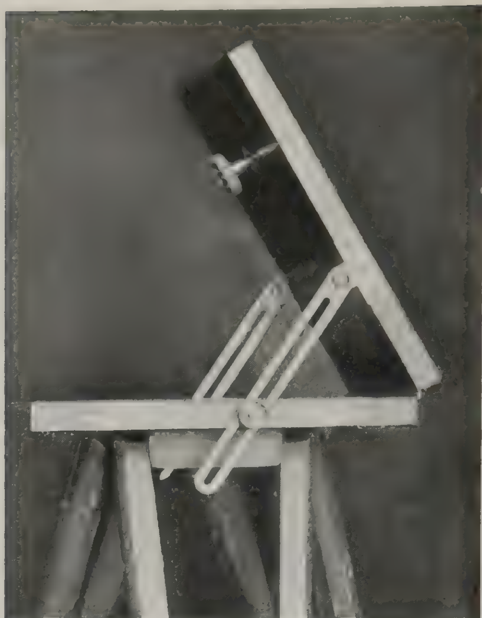


Fig. 296.—Tripod Top for Pointing Camera Downward.

Supplied by dealers and very useful. Many of the figures in this book were made possible by this device.

Fig. 297.—A Home-made Device for Pointing the Camera Downward.

Consisting of two boards, three clamps, two brackets, a tripod top, and two bolts. The upright board is slotted to allow vertical motion for easier adjustment. The whole is clamped to an ordinary stepladder. This was used in taking a number of the figures in this book.

FIG. 298 shows a common stepladder on which is clamped the camera holder, consisting of two boards joined by hinges, and on the sides transom rods are attached to regulate the angle. Many of the pictures in this book were made by means of this device, which I made for the use of the author of a well-known work on postmortems.

Note the way the morgue refrigerator stretcher is raised on a stool and the construction of the head block.

(2) The plates for postmortem work which will give best results are double coated and slow. I find the Standard Orthonon very satisfactory. In clinical work it may be necessary to have a faster plate, but

then the operator must be expert or his errors in exposure will be serious.

(3) *Illumination.*—A very common error is to have too much light or to have it from too many sources—the result is entire loss of effect. One good north window will do. Light directly over the object is usually bad. Various electric lights have been devised, but one can get along with a common arc lamp hung not over 5 feet from the object, and, if possible, it should be movable. The high-grade composition-flaming arc lamps reduce the exposure greatly, but are expensive, hurt the eyes, and give too vivid shadows at times, though at other times they help by increasing the contrast. Flashlights may be used, but are very unsatisfactory in use and effect, and only serve in emergency.

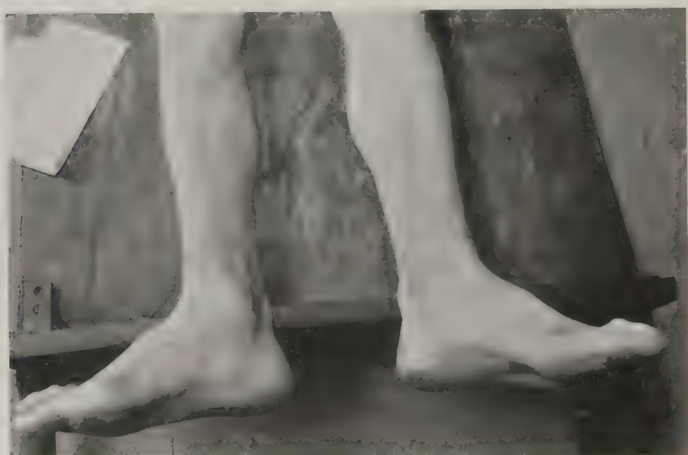


FIG. 299 SHOWS THE EFFECT OF ILLUMINATION.

The light comes from a large window on the left. Compare the two ankles. The right ankle shows contour, while the left one appears utterly flat. An otherwise good picture may be ruined by disregarding the shadows. Note the piece of newspaper. This should always be used to get the exact focus.

(4) The development should not be hurried, and should be done in a dark room into which no outside light enters, the effects watched with a safe light, and the development carried on with regard to that part of the picture most valued. Some effects can only be obtained by over-exposing the plate and guarding the development.

(5) The use of color screens is advocated by the dealers, and is of use at times, but generally the extra time and trouble is only rewarded by a picture of less contrast and clearness. This applies to work on anatomic and pathologic material generally, but does not apply to objects where the contrasts are already too great. In the body the predominance of reds and yellows makes the ordinary yellow screens of little value, and the green one is so slow that what one gains in added contrast is lost in time. It is better to manage the matter of contrasts in organ work by development, bromids, and grades of printing paper.

(6) *Stopping or Diaphragms.*—I always use the smallest one so as to get detail, except in emergencies where speed is necessary.

(7) *Focusing.*—I place a bit of newspaper upside down on the part and focus with full aperture, and take the middle point between the two points when the print becomes clear in focusing down and up.

(8) The position of the object should be such that it is firmly supported and will not slip or stretch. This is often hard to arrange, but the extra time and energy is well spent that prevents movement during the exposure. Fully as important is the position in relation to the illumination. Fig. 299 shows the effect of the relation of object to light.

A larger proportion of the failures in medical photographs is due to this than to any other single thing. The camera is very sensitive to lights that are overlooked by the average untrained eye. The light can seldom be arranged to suit all parts of a picture. If the natural contrasts are sharp, a diffuse light should be used; if they are slight, a concentrated light, so placed as to increase contrasts, is the solution of the problem. Avoid reflections from the surface of organs by being sure that the angle made by the line from the object to the camera is never an obtuse one with the line from the object to the source of light. It is well to have the light enter the tissue as far as possible, to get true texture effects, and this is best obtained where the angle formed by the line from light to object and the object to camera is small. However, certain effects are brought out by oblique illumination (see Fig. 215). Rarely one needs to have transmitted light to show structure (see Fig. 246).

(9) Keep full and complete *records* of every exposure. Study these with the results obtained.

(10) *Printing.*—I prefer a double-weight paper, with moderate gloss and high contrast, or what is called a hard paper, and enough bromid to moderately restrain the developer. I also prefer a rather long development on account of the depth of detail. I have mentioned many things which one would suppose offhand that an expert photographer would know all about because I find that such matters are not generally known even among successful photographers. I have had to glean from many sources, personal and printed.

I wish at this time to express my high appreciation of the great kindness, courtesy, and expertness of Mr. Harry Botkin, Photographer of the Department of Public Safety of Philadelphia, whose valuable advice has helped me in many matters and often made possible the solution of photographic problems that arose during the preparation of this book.

WEIGHTS AND MEASURES

MENSURATION

Skill in taking measurements of the different parts of the body is seldom attained without much labor and trouble. The untrained person who is armed with all the implements is more than likely to make very surprising records, specially if he measures the same body several times. The question may be well asked whether the results of ordinary measurements on the dead body are worth the making. The answer should be that they will not be worth making unless the person is willing to undergo the severe training required to perfect himself in the technic and in anatomy, as the results of the usual methods are so bad that they are worse than useless, but if such measurements are carried out systematically and properly they will be of great value. We find a great many records of series of measurements of school children where the results are vitiated by the defects of the methods employed. The average error is usually greater than 1 per cent., and should not be half that amount.

Usually at the postmortem the measuring of the body as a whole is neglected, and the organs are subjected to a more or less elaborate system of measuring, and the error is not infrequently very high because what efforts are made toward accuracy are made toward measuring the wrong lines or angles.

If we are to adopt a system of measuring the body, let it be in harmony with the best methods of modern anthropometry, so that the results when obtained may be used to throw light on the results of that art.

These anthropometric measurements on the body include what are called bone measures, but are simply distances between landmarks, and include all joint structures as well as bones. With these "bone" lengths are combined the various circumferences and the lengths of certain axes.

Gymnasium pseudo-anthropometry is to be found where much is made of muscle measures. These are intended to appeal to boys and philanthropists, and do not interest us because the second measurements always show "improvement."

Great stress has been laid on craniometry, and here various axes or diameters are first carefully determined and measured, and the angles these make with each other and with various tangents and other planes and lines are elaborately worked out. Unfortunately, the results obtained are at present of far too little practical value to warrant a more extended discussion of this interesting and valuable scientific work.

At the postmortem we have an opportunity to obtain measurements which will have great scientific and practical value, provided they

are wisely made. The only proper and wise method is one which includes both the usual anthropometric body measures and rightly made organ measures. Such work should only be undertaken when one can devote time and energy enough to assure rightness of method, accuracy of results, and complete and systematic recording of at least several hundred cases. A few isolated cases will be of little value, and may seriously mislead rather than instruct. The spasmodic measuring along carelessly selected axes or on ill-determined lines or between vague or movable landmarks are seldom more than a waste of time and energy. On the other hand, every correct measurement has a little, almost infinitesimal, value, and the measuring if done thoughtfully may add just a little to our knowledge of the part; but the chief objection is that we almost invariably overestimate the value of such work. To spend an hour making elaborate measurements of organs on an incorrect system, with no regard to the condition of the organs as to extension, compression, or flexion, is to seriously injure the mental make-up of the operator, very much as it injures a child to use words ungrammatically.

The astonishing frequency of this faulty way of measuring organs makes it desirable to present the subject rather fully and sharply.

I have watched eminent operators measure with extreme care a brain that had been removed and laid on the table. The measurement recorded for width was considerably greater than that of the inside of the skull from which the brain came; the length recorded was longer than the skull measure, though the difference was relatively less and the thickness was less than it should have been. The simple fact that the brain settles and flattens had not been remembered, and the measurements were wholly worthless because no word was given to indicate the consistency of the mass so that the amount of settling could be estimated.

No two brains will settle in just the same way, the spreading depending on the texture, on the membranes, on the vascular contents, on the lateral ventricles, on the time of life, on the time since death, on the postmortem changes, and on the amount of handling. But this is not the worst of the matter. I have read elaborate records of measurements of hardened brains where the operator had not—on his own confession—the slightest idea of the action of the hardening compound used on the size, nor had he even thought to take measurements of the interior of the skull to use as a control of his later measurements.

Once I ventured to suggest that the results would be more useful if the brain was suspended in a saline solution similar to the cerebrospinal fluid, at least so far as its specific gravity, but the mind of the operator was so filled with ingrained error that there was no room for common sense.

Take the ordinary heart measurements as another example of this habit stupidity. Most measurements are made of the organ after it has been handled, cut open, removed from the body, washed, squeezed, and further distorted. Under such mishandling two hearts of exactly the same dimensions will yield entirely different measurements, and the

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difference will depend on the softness, congestion and postmortem changes as well as on the violence done by the operator.

The time to measure the whole heart is before it has been touched. The thickness of the heart is usually measured after it has been bent and twisted and variously manipulated; only in the firmest sort of muscle will this fail to have a marked effect.

So the intestines are measured after being cut away and usually very thoroughly pulled in the process. The liver is often given a measure of width that would extend beyond the abdominal walls.

If one cannot apply common sense to the problems of mensuration the measuring of organs had better be omitted entirely, as the results are sure to be worse than useless. We read of abnormally small aortas when we are sure that had the tube been distended by the normal blood-pressure it would have expanded possibly enough to reach an average size. Anyone who has palpated a pulsating aorta in the type where the so-called contracted aortas are so often found knows how much it expands under pressure of the pulsation. The greatest confusion is usual regarding distention, dilatation, contraction, and size. No measurement is finished until these four factors are determined.

One might just as well measure the mouth of a comedian in any one phase of an evening's performance as to record measurements of changeable organs in some more or less accidental position or condition. The only rule for making measurements is to study the nature and properties of the organ, and use good common sense in avoiding measuring the results of handling, distortion, contraction, and various other more or less accidental conditions.

Measures of length and breadth and thickness all have a limited value when taken by themselves; when taken with actual volumes they have vastly more meaning, and this is still further increased when there is a sensible description of the shape so given as to convey data that can be considered as part of the measuring, and to be used as a basis for an estimate of the total mass of the organ and its shape significance.

Absolute units of measurement have vastly less significance than the relative size as compared with the body as a whole and its other parts. To secure a conception of the value of an organ we must combine its size, shape, volume, and the proportion of parenchyma to skeletal tissue, and also the included fat, blood, and other fluids, and the condition of these parts. To secure an understanding of the value of that organ in the body we must compare its individual value with a similar value, separately worked out, for the whole body, and this must be corrected by the results obtained by a similar valuation of all the other organs related to the particular organ, and by the special needs of the body for the peculiar function performed by that organ.

WEIGHTS—VOLUME

The taking of the weights of the organs and parts is generally less difficult, but the errors which are likely to be made are no less serious in effect.

Where any degree of accuracy is desired the dissection must be carried on most cautiously, but usually the limit of allowable error is large. It should always be remembered that edema increases the weight of an organ, while it disappears during the dehydration of the tissue during the preparation for the microscope, so that one looking at the sections and noting the weight would fall into a serious error if he attempted to estimate the value of the organ.

The blood contained in an organ, either normally or as a congestion, further modifies the true as compared with the apparent weight. Fat in or about the organ often complicates matters. The dissection of the organ should be made carefully and according to an arbitrarily fixed routine if one is making a series of records, special care being had regarding the exact length of attached blood-vessels, ducts, or ligaments left on; also the handling and washing and dryness of the organ are to be carefully controlled.

The specific gravity of the various soft tissues of the body does not differ very greatly from that of water, so that if we know the weight in grams we know approximately the number of cubic centimeters the organ measures. If, however, one is desirous of really investigating the condition of any tissue he will weigh a portion in air and then in water, and at the same time note its actual volume while weighing it in water. From these he readily calculates the specific gravity.

The methods for these determinations are illustrated and described under Technic. Volumes of cavities can easily be measured by pouring from a graduate small shot, and noting the amount remaining in the graduate. This method is applicable where the cavity is not sufficiently closed to permit the use of water or mercury. The shot may be kept in a graduated bottle and can be washed, allowed to dry, and then returned to the bottle; or, if one is very particular, glass beads are better. In measuring the volume of distensible organs, like the bladder, stomach, etc., one uses water and a well-secured cannula attached to a long tube, at the end of which is a funnel or bag or, better, a graduated vessel, and notes the amount at various pressures.

The interpretation of weights and measures has hardly begun to be recognized as a subject of great importance. Many tables have been prepared by European observers, but the too general tendency has been to take averages of various series rather than to determine the significance of the relations or proportions in individual cases. While such general tables are of value, they are apt to be misleading. In our studies at the postmortem it is the individual that interests us, and we want to know what evidence there is of disproportion and what it means, whether it is due to type, development, habit, condition, or disease.

To determine the existence of disproportion we must have some standard of comparison and would be glad if such a standard existed; unfortunately, it does not exist. The best we can do, therefore, is to make an individual one by studying all cases we see, and using such imperfect tables as are obtainable, but using them with full recognition of their imperfection rather than as fixed and reliable standards. In the

matter of body weight and height we have certain tables collected by the insurance workers that are not only interesting but valuable, though they do not go very far.

The stature, or body height, is far more definite than the body weight, and gives us very often valuable data regarding type, congenital and acquired characteristics, and nutritional factors. The body weight varies greatly from many causes, so that the careless comparison of the weight of an organ with that of the body is apt to be very misleading.

The body weight for a given height is significant because it gives evidence of nutritional peculiarities which affect health and longevity.

The amount of fat, muscle, bone, and other skeletal tissues, however, varies so greatly with habit and type, occupation, and feeding that one must estimate—for one cannot actually weigh them—each in all comparisons. It is, therefore, well to cultivate the habit of estimating the weight of everything that is weighed so as to develop the ability to judge in these matters, remembering that in soft tissues the bulk and weight are nearly equal, using the metric system; which is best for scientific work, but should not be used in medicolegal work on account of its not being so generally understood.

The use of the metric system in evidence in courts is undesirable; it is, therefore, necessary to maintain two standards and to have easily accessible tables. To use the Troy System is entirely inexcusable. Also to use colloquial measures, such as a hen's egg or a bean or any other object, is undesirable except on rare occasions for court work. It is, however, to be remembered that the colloquial names of shapes are the basis for most scientific descriptions, and though they are scrupulously latinized, it is better for court or other public purposes to translate them literally into the common language.

It is interesting to remember that most of the units of length were derived from the human body—cubit, digit, ell, fathom, finger, foot, hand, inch, pace, span, yard, etc.

No one familiar with the way weights and measures of the organs vary with conditions can possibly be satisfied with any existing table. Each author has had a slightly different standard, depending on some peculiarity of the series he has studied.

I have compiled from many such lists a table which, while it has no scientific value, may help to bring the subject before the mind of the student in such a way that he will be better able to consider the problems involved in mensuration.

If this table is compared with the other tables, specially those from the records of the Philadelphia General Hospital, it will be easily seen how misleading are averages even when the data is carefully collected from a great many cases. I have purposely avoided introducing many details that can be gleaned only at considerable labor from the literature, because I am firmly convinced that only those who are specially trained should indulge in this type of work, and that the spending of valuable time and energy on such work, when there are vastly more important things to do, is a great mistake, which I do not care to encourage.

COMPILED WEIGHTS AND MEASURES

Organ.	Weight.	Length.	Breadth.*	Thickness.	Specific gravity.	Proportion to body.
Brain	1000–1700	0.16+	0.13+	0.12+	1040	2.0%
Cord	30+	0.50	0.01+	0.008+	......	.05%
Glands:						
Mammary	150–900	0.1+	0.12+	0.05+	All glands about 1050	
Parotid	20–30	....	....	....		
Prostate	15–35	0.25+	0.35+	0.02		
Sublingual	2–4					
Submaxillary	7–10					
Suprarenal	5–10	0.05±	0.03±	0.005±		
Thymus	3–5					
Thyroid	25–40	0.03+	0.06+			
Heart	100–360	0.1±	0.09±	0.35±	1050	0.5%
Aorta	30–50	....	0.017–0.03	†0.0015+	1070	
Intestines:						
Duodenum	....	0.25	0.02+			
Small	630–700	6.–8.	....	....	1040±	
Colon	460–500	1.4–1.7	0.6±			
Kidneys	200–350	0.1–0.13	0.05–0.06	0.03–0.04	1050	0.45%
		Transv.	Vert.	Ant.-post.		
Liver	1200–2000	0.20–0.35	15±	0.14±	1050+	2.5+%
		Vert.	Ant.-post.	Transv.		
Lungs	700–1300	0.26±	0.16±	0.1±		
Ovary	5–10	0.03+	0.015+	0.012+		
Pancreas	30–150	0.17+	0.04+	0.03+	1045	
Spleen	100–200	0.1+	0.08+	0.03+	1035+	0.25%
Stomach	125–175	0.25	0.1–0.14	†0.006+		
Esophagus	25–50	0.2–0.3	0.04+	†0.008+		
Testicle	10–30	0.04+	0.025+	0.02±	1040	
Uterus, virgin	30–50	0.06+	0.035+	0.02+	1050	
After childbirth	50–100	0.07+	0.04+	0.025+		
Bladder	30–60					

* of tubes = diameter. † of wall.

In order to show the range of variations in weights of the larger organs I have compiled several tables from the records of postmortems at the Philadelphia General Hospital. For permission to use these I am indebted to Professors Smith, Coplin, and McFarland, who most courteously and freely allowed me to use such records as I needed.

I took two groups of 100 each—one of males, one of females. The percentage of colored was 13 in the male group and 27 in the female group. The ages varied from twenty to eighty years, about evenly divided, with a few over eighty (3 in each group) and a few under twenty (3 males, 5 females). The prevalence of tuberculosis and pneumonic conditions raises the lung weights far above the average in health; this would raise the average weights, but by the method of tabulating this does not affect the results because the mean is taken rather than the average weight, and this mean represents fairly well the normal. It must be clearly understood that these tables are not introduced to establish a fixed weight for any organ, but to show the problems which present themselves in the study of weights, and the way to compare such data so as to gain an insight into such problems.

WEIGHTS OF ORGANS, PHILADELPHIA GENERAL HOSPITAL

	Under 70 Gm.	Over 70, under 100	100	110	120	130	140	150	160	170	180	190	200	250	300	Over 400
SPLEEN: 100 males....	4	11	7	8	8	5	7	4	4	5	3	5	16	4	6	3
100 females...	17	23	6	7	7	2	4	5	6	1	4	1	9	3	3	2
LEFT KIDNEY: 100 males....	.....	5	1	6	6	8	5	8	9	12	6	14	20			
100 females...	.....	9	11	8	11	9	8	13	4	9	2	8	8			
RIGHT KIDNEY: 100 males....	.....	4	3	3	6	8	7	11	7	9	6	8	28			
100 females...	.....	9	10	5	15	16	7	13	4	7	5	3	6			

		Under 200 Gm.	200	220	240	260	280	300	320	340	360	380	400+
BOTH KIDNEYS: 100 males....	.....	3	4	5	4	8	6	8	10	6	16	9	21
100 females...	.....	13	6	12	13	10	11	8	6	5	6	3	7

	Under 1 Kg.	1.	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	Over 2.0
LIVER: 100 males....	5	2	8	11	11	6	16	13	2	5	11	10
100 females...	10	10	15	10	10	12	8	5	5	5	4	6

	Under 200 Gm.	200 to 300	300 to 400	400 to 500	500 to 600	600 to 700	700 to 800	800 to 900	900 to 1000	1000 to 1100	1100 to 1200	Over 1200
LEFT LUNG: 100 males....	1	10	13	23	17	13	9	8	1	2	1	2
100 females...	2	17	31	24	16	5	2	...	1	2		
RIGHT LUNG: 100 males....	1	2	7	8	18	15	12	8	10	4	8	7
100 females...	.....	9	30	22	11	18	3	2	2	1	...	2

	Under 400 Gm.	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900+
BOTH LUNGS: 100 males....	1	.....	6	1	4	5	11	8	10	8	9	4	4	7	5	5	12
100 females...	.....	5	10	10	17	17	7	9	12	6	4	1	1	2	..	..	1

	150 to 200 Gm.	200 to 250	250 to 300	300 to 350	350 to 400	400 to 450	450 to 500	500 to 600	600 to 700	700 to 800	800 to 900	900+
HEART: 100 males.....	3	16	16	22	14	13	4	4	3	4	...	1
100 females...	7	23	16	27	11	7	4	2	1	2		

WEIGHTS OF ORGANS, PHILADELPHIA GENERAL HOSPITAL

	100 Males.			100 Females.		
	Min.	Mean.	Max.	Min.	Mean.	Max.
Heart	190	340	920	150	310	790
Left lung	140	500	1840	160	400	1020
Right lung	160	700	2130	230	450	1450
Both lungs	300	1250	2960	430	850	2240
Spleen	30	150	590	20	125	400
Left kidney	60	175	330	40	145	310
Right kidney	50	170	440	50	140	380
Both kidneys	110	340	680	140	270	690
Liver	840	1550	3370	490	1350	2770

This table is constructed to show at a glance the variations in weights of these organs.

The lightest or minimum, the heaviest or maximum, and the approximate mean or line above and below which are equal numbers of cases, and these in each sex from postmortems made at the Philadelphia General Hospital.

From a comparison of the weights of the kidneys it was found that the left kidney weighed—

More than right.	Weight was equal.	Less than right.
In 47 males	In 4 males	In 49 males
In 52 females	In 3 females	In 45 females

That the total of differences between the two kidneys were 1330 gm. males, 1270 gm. females; for left over right: 1340 gm. males, 1060 gm. females; for right over left: giving -10 gm. males, 210 gm. females, as final balances. This could hardly be a confirmation of the often repeated statement that the left kidney generally weighs more than the right, though the selection of the approximate mean seems to yield such confirmation.

The table on page 568 gives an excellent representation of how these two organs vary with relation to each other. On the left the heart weights; above, the weights of both kidneys. In the second column will be found the number of males (above) and the number of females (below), showing the stated weight of heart. These male and female lines are carried across, so that the number of each, showing kidneys of given weights, can be directly read. It will be seen that in 46 males and 54 females the heart weighs more than both kidneys; in 6 males and 6 females the heart weighs the same as both kidneys; in 48 males and 40 females the heart weighs less than both kidneys; therefore it is evident that the variation, while very great, balances in the males and shows a tendency for the kidneys to fall below the heart in females.

WEIGHTS OF HEART COMPARED WITH BOTH KIDNEYS

Weight of Heart.		100 to 200	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400	500	600	700
Under 200...	M. 2	1											1													
	F. 7	1		1		1		2		2																
200...	M. 1																			1						
	F. 6					1		2			1				1				1							
210...	M. 1								1																	
	F. 1																								1	
220...	M. 3									1					1	1										
	F. 6				1			1				1		1									2			
230...	M. 0																									
	F. 7	2		1		1		1	1	1																
240...	M. 7			1			1					1		1					1				2			
	F. 2						1										1									
250...	M. 6	2												1		1		1				1				
	F. 6	1			1	1			1			1									1					
260...	M. 3																		1	1			1			
	F. 0																									
270...	M. 2																					1	1			
	F. 6	1		1							1							2					1			
280...	M. 4													1	1		1					1				
	F. 4	1									1								1				1			
290...	M. 4								1					2									1			
	F. 0																									
300...	M. 3																	1					2			
	F. 13	3						3			1	1	1		2				2							
310...	M. 4							1		1						1	1									
	F. 4			1				1				1	1													
320...	M. 7											1			1						1	1	3			
	F. 3	1			1															1						
330...	M. 3					1						1								1						
	F. 4			1				1						1								1				
340...	M. 8		1		1									1	2				1			1		1		
	F. 3									1		1							1							
350...	M. 2									1	1															
	F. 5				2							1									1		1			
360...	M. 2															1					1					
	F. 0																									
370...	M. 4											1				1				1			1			
	F. 3							1						1			1									
380...	M. 2				1														1							
	F. 1															1										
390...	M. 2				1													1								
	F. 1	1																								
400...	M. 18			1		1			2	1	1		1						3	1	1	1	3		1	1
	F. 12	2		1		1	1			4		1	1		1											
500...	M. 4																1		1	1		1				
	F. 2												1			1										
600...	M. 3														1				1				1			
	F. 2																						1	1		
700+.	M. 5															1			1	1			1	1		
	F. 2					2																				
100 M.......	M.	3	1	2	3	2	1	1	4	4	2	4	2	6	6	6	3	3	10	7	3	7	16	2	1	1
100 F.......	F.	13	0	6	5	7	2	12	2	8	4	7	4	3	4	2	2	2	5	1	2	1	6	1	1	0

WEIGHTS OF BRAINS

Table Compiled from Postmortems of the Insane

PUBLISHED BY THE STATE HOSPITAL FOR THE INSANE, NORRISTOWN, PA.

Classed.	Under .8 kg.	.8–.9.	.9–.1.	1.–1.1.	1.1–1.2.	1.2–1.3.	1.3–1.4.	1.4–1.5.	1.5+	
Males:										
Dementias	...	1	8	11	35	36	40	14	8	153
Imbecility	...	1	1	2	2	3	3	...	4	16
Manias	...	...	...	7	17	12	22	11	4	73
Melancholia	...	...	1	2	6	13	16	5	8	51
Paresis	...	...	3	6	11	14	14	2	...	50
Total males	...	2	13	28	71	78	95	32	24	343
Females:										
Dementias	...	3	16	40	59	53	22	6	4	203
Imbecility	1	2	3	2	3	1	2	...	...	14
Manias	...	...	3	17	35	32	17	5	4	113
Melancholia	...	1	5	9	16	24	11	6	1	73
Paresis	...	...	5	9	5	3	...	...	...	22
Epilepsy (only)	...	...	...	1	6	6	3	3	...	19
Total females	1	6	32	78	124	119	55	20	9	444
Total both	1	8	45	106	195	197	150	52	33	787

Some scattering cases where there were few under each heading have been omitted. Subdivisions of classes were necessarily not regarded. Note the low weights in paresis and the high weights in melancholia. The median for males is about 1250 gm. The median for females is about 1150 gm. The median for all is about 1200 gm. 75 per cent. of males range between 1100 and 1400 gm.; 50 per cent. of males range between 1200 and 1400 gm.; 75 per cent. of females range between 1100 and 1300 gm.; 50 per cent. of females range between 1100 and 1300 gm. Females average 100 gm. less or about 10 per cent. of total weight.

In the recently published report of the Medico-Actuarial Mortality Investigation, published by the Association of Life Insurance Medical Directors and the Actuarial Society of America, we find some extremely interesting and valuable material from which the four following tables are taken:

RELATION OF AGE TO WEIGHT

Age.	Males.		Females.	
	Number.	Average weight.	Number.	Average weight.
15–19	5,227	138.9	4,596	124.1
20–24	34,293	148.2	22,187	127.9
25–29	49,709	152.6	31,300	130.5
30–34	46,299	156.7	28,251	133.9
35–39	36,217	160.1	21,391	137.4
40–44	23,941	162.2	13,406	140.7
45–49	13,700	164.4	8,117	143.1
50–54	7,406	165.5	4,570	145.0
55–59	3,609	165.3	1,995	145.0
60–64	1,144	165.3	576	143.9
65–84	260	166.0		
65–74	.....	......	112	138.2
55–84	5,018	165.3		

These figures are from the examinations made on applicants for life insurance in the United States and Canada from 1885 to 1900 inclusive, and include over 221,000 males and 136,000 females.

BUILD, OR RELATION OF HEIGHT AND WEIGHT WITH AGE. MALES, WITH FOUR POINTS OF COMPARISON WITH FEMALES

Height.	Ages.					
	25–29.	30–34.	35–39.	40–44.	45–49.	50 and over.
5 ft.	124	127	129	132	134	135
" *Females.*	*118*	. . .	*124*	. . .	*131*	*133*
5 ft. 1 in.	126	129	131	134	136	137
5 ft. 2 in.	128	131	133	136	138	139
5 ft. 3 in.	131	134	136	139	141	142
5 ft. 4 in.	134	137	140	142	144	145
" *Females.*	*129*	. . .	*136*	. . .	*142*	*144*
5 ft. 5 in.	138	141	144	146	148	149
5 ft. 6 in.	142	145	148	150	152	153
5 ft. 7 in.	146	149	152	154	156	158
5 ft. 8 in.	150	154	157	159	161	163
" *Females.*	*144*	. . .	*152*	. . .	*159*	*163*
5 ft. 9 in.	154	158	162	164	166	168
5 ft. 10 in.	158	163	167	169	171	173
5 ft. 11 in.	163	168	172	175	177	178
6 ft.	169	174	178	181	183	184
" *Females.*	*159*	. . .	*165*	. . .	*173*	*177*
6 ft. 1 in.	175	180	184	187	190	191
6 ft. 2 in.	181	186	191	194	197	198
6 ft. 3 in.	187	192	197	201	204	205

RELATION OF WEIGHT TO MORTALITY

This table is based on 744,672 examinations of men who were above or below the average weight for their age.

The ratio of actual deaths which had occurred (amounting to 41,717) as compared with what would have been expected from a previously prepared standard table of mortality is shown as per cent. in each group. The expected deaths would be 100 in each case. The table is combined from data in Vol. II of the report of the Medico-Actuarial Mortality Investigation:

Ages.	20–24.	25–29.	30–34.	35–39.	40–44.	45–49.	50–56.	57–62.
Under Weights:								
−25 to −45 lbs.	134	116	108	102	97	89	91	81
−15 to −20 lbs.	115	108	100	103	87	99	92	82
−5 to −10 lbs.	107	99	104	91	85	97	90	93
Average.	99	93	106	96	99	100	88	92
Over Weights:								
+5 to +10 lbs.	96	93	99	100	94	103	102	102
+15 to +20 lbs.	96	90	86	101	110	109	121	125
+25 to +45 lbs.	101	112	119	131	140	131	124	112
+50 to +80 lbs.	103	117	134	155	175	151	149	138
Combined over and under weights.	114	108	108	111	113	110	112	100

RELATION OF HEIGHT TO WEIGHT

From "Medical and Actuarial Reports"

Height.	Males.			Females.			
	Number.	Average weight.	Increase per 1 inch.	Number.	Average weight.	Increase per 1 inch.	
4 ft.	.....	.....	.....	2			
4 ft. 1 in.	.....	.....	.....	6			
4 ft. 2 in.	.....	.....	.....	12			
4 ft. 3 in.	.....	.....	.....	7			
4 ft. 4 in.	.....	.....	.....	13			
4 ft. 5 in.	1	.....	.....	19			
4 ft. 6 in.	.....	.....	.....	19			
4 ft. 7 in.	4	.....	.....	19			
4 ft. 8 in.	5	.....	.....	68	112		Weight F.
4 ft. 9 in.	17	.....	.....	202	116		less than
4 ft. 10 in.	19	.....	.....	586	118	2	M. for
4 ft. 11 in.	38	.....	.....	1,305	120	2	same
5 ft.	396	.....	.....	5,459	122	2	height.
5 ft. 1 in.	441	129	.....	7,517	124	2	5
5 ft. 2 in.	1,198	131	2	14,654	126	2	5
5 ft. 3 in.	2,625	133	..2	18,375	129	3	4
5 ft. 4 in.	6,591	137	4	25,105	132	3	5
5 ft. 5 in.	12,130	141	4	22,798	136	4	5
5 ft. 6 in.	22,057	145	4	18,236	140	4	5
5 ft. 7 in.	28,086	149	4	11,384	144	4	5
5 ft. 8 in.	37,544	153	4	6,591	148	4	5
5 ft. 9 in.	32,248	157	4	2,508	152	4	5
5 ft. 10 in.	32,718	162	5	1,072	156	4	6
5 ft. 11 in.	23,014	168	6	385	159	3	9
6 ft.	14,585	174	6	130	162	3	12
6 ft. 1 in.	4,783	180	6	17			
6 ft. 2 in.	2,342	186	6	8			
6 ft. 3 in.	669	191	5	4			
6 ft. 4 in.	229	200	9	1			
6 ft. 5 in.	53	.....	.....	1			
6 ft. 6 in.	17						
6 ft. 7 in.	3						
6 ft. 8 in.	3						
6 ft. 9 in.	2						
6 ft. 10 in.							
6 ft. 11 in.	1						

REPAIR OF BODY

Throughout the previous sections will be found various hints regarding the methods of examination which will be desirable because of the greater ease of repairing and restoring the body; also under Technic the matter has been briefly touched upon.

There are many suggestions in the literature, and all practical workers have more or less special methods which have merit.

A well-trained assistant usually can be trusted to attend to all such matters, but few in this country are fortunate enough to have such.

An experienced embalmer often possesses unusual skill in all sorts of repair work, but for the many occasions where one has to either attend to it himself or instruct an unskilful assistant some of the following suggestions will be found useful.

The repair of the body after the ordinary examination will consist in the removal of all blood and other fluids, the replacement of the organs in their approximate positions, and the closure of the cuts by suitable sutures. Ordinarily, there will be little difficulty in this task, but in the case of very fat bodies, or where pregnancy has advanced, or large growths are found, it requires care.

Where only partial examinations have been made, and the bowel has not been fully opened or where postmortem changes have advanced very far, the tissues may have to be freely punctured to allow the accumulated gas and fluids to escape before the flaps can be closed. In cases of advanced decomposition the skin will not give sufficient support and the stitches will then tear out, so that it may be necessary to resort to bandages to reinforce the sutures.

There are several forms of suture, of which the two most useful types are shown. It is at times necessary to fasten the suture at several places. In very fat persons this must be done to prevent bursting open. In closing secondary or special cuts one must select the suture with regard to the conditions. If the skin is drawn tense and there is none to spare, the baseball stitch is the best, or if the skin is very easily torn it may be necessary to use the stitch which resembles the lacing of a shoe, where only one end of the lace is used, going into one flap and coming out in the other flap, holding the parts together while tightening the twine rather than using much traction on the stitches to draw the parts together.

The placing of substances, such as cotton, okum, cloth, or paper, in the body should be avoided as far as possible. At times a bit of clean cloth may be used to take up fluids which will otherwise leak out. This is, however, seldom necessary in the thorax and abdomen.

In repairing the pelvis it is often desirable to place a considerable pad over the floor to prevent materials from running out of the cut vagina or

rectum; for this purpose either absorbent cotton or cotton-batting give good results, but an old towel or bit of cloth will serve.

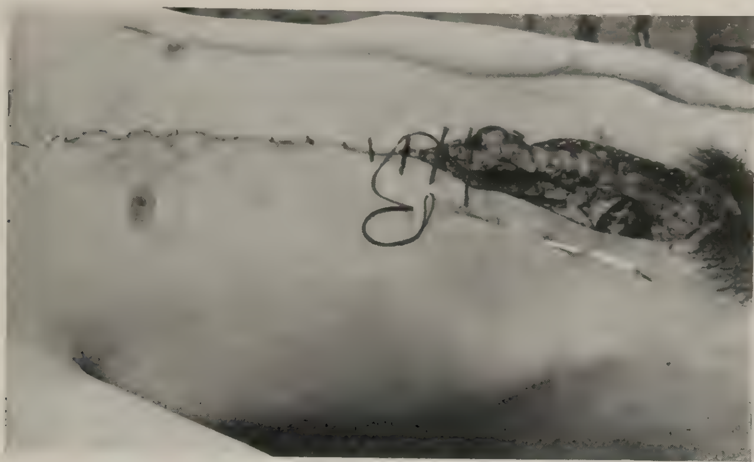

FIG. 300.—THE "INVISIBLE" STITCH, WHICH I PREFER.

The thread is used double and is fastened in the upper part of the cut. The needle is passed in and out on one side and then in and out on the other side. By carefully spacing the most satisfactory effect is produced.

In using cotton care should be taken not to place it where it will engage the needle or any undertaker's instrument, as it causes great annoyance.

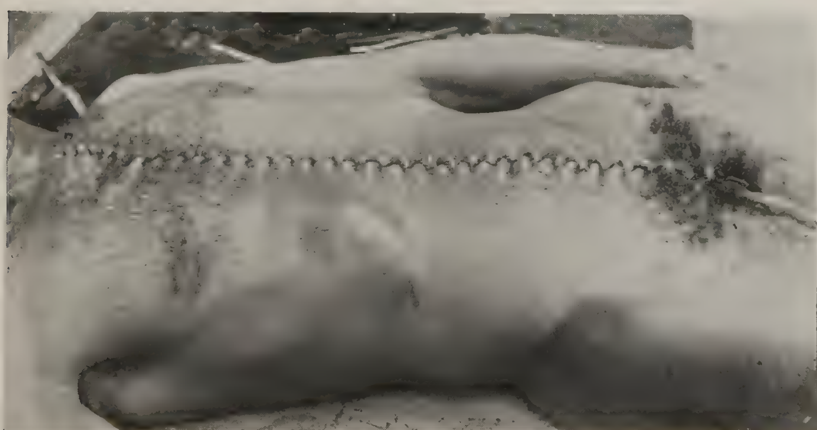

FIG. 301.—THE STITCH USUALLY ADVOCATED, GENERALLY CALLED THE "BASEBALL" STITCH.

The needle is passed from within outward, alternating sides. It is a trifle stronger than the "invisible," but takes more time and twine and does not look so well when done.

I very strongly object to the use of okum, but fear that my reasons for this are largely esthetic.

In sewing up infected bodies great care should be taken to prevent the escape of fluids unless antiseptics have been freely used. It is desirable, and should be made compulsory by law, that all infected bodies should be freely disinfected after the postmortem and before they are completely closed up.

Wherever possible I have the undertaker put into the cavities a strong fluid when I have reached the lower belly, as seen in Fig. 300.

The flaps are slightly separated and raised and several pints of fluid can then be poured in, and through the opening the organs and tissues can be moved about so that the fluid reaches every part in the cavities. This is much to be preferred to the method of pumping in fluid through a trocar after the body has been closed. An expert embalmer will prefer to have the body left open so that he can more fully prepare it before closing the sutures. In all sutures it is necessary to so judge the stitches as to have the opening close without puckering or dragging on either flap.

In all sewing one must remember that needle wounds are the most dangerous sort at a postmortem, because they go in quite deeply and are hard to disinfect. It is very important to cultivate the greatest caution in the use of the needle. I am extremely particular about holding the needle so that it cannot possibly slip and wound either myself or an assistant. Too much care cannot be exercised in this matter.

In closing the cut made in the removal of the spinal cord it is best to replace the tissues as nearly as possible in their normal position. If bleeding is free I have at times found it best to pack the spinal canal with cotton or cloth. Where extensive dissection of the spine has been made, the best possible repair should be made before the final suture is begun. The leaking through such a suture is apt to be considerable, no matter what care is taken, and if the undertaker is present he should be warned as to what is likely to happen; if he is not present, a pad of some sort must be placed below the body before leaving it. If nothing better can be obtained a lot of crumpled newspapers will often serve.

It is not enough to clean up after a postmortem and leave a leaking body to ruin carpets or bedding, one must anticipate the leaks that cannot be avoided, and see that they will do no damage after the operator has gone away.

In making cuts it is well always to remember the problems of repair. Generally such cuts will be made so as to avoid disfiguring those parts usually displayed at the funeral, but it is well to bear in mind that fluids settle and tend to leak out of openings in dependent parts.

In opening the head of a bald-headed man the problem of repair often presents real difficulties. A cut wholly within the hair has been advocated instead of one over the vertex, from behind one ear to a corresponding point on the opposite side. Such a curved cut through the scalp may be desirable and offers no serious difficulties. It may begin and end as does the usual cut, but sweeps backward, so that the anterior flap is quite large. When the skull is fractured or very fragile the

V-shaped cut may be modified, so that instead of having two bone cuts there will be four, making a parallelogram with two of the points behind

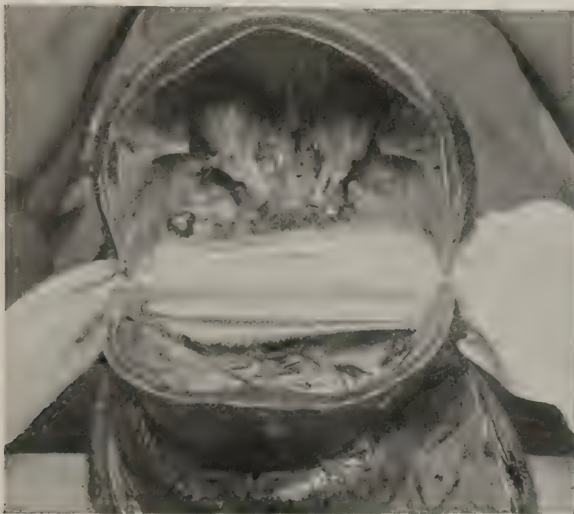

FIG. 302.—REPAIR OF SKULL. (A.)

The cuts having been carried down for about an inch, a muslin bandage at least 3 inches wide is passed into these cuts and drawn tight.

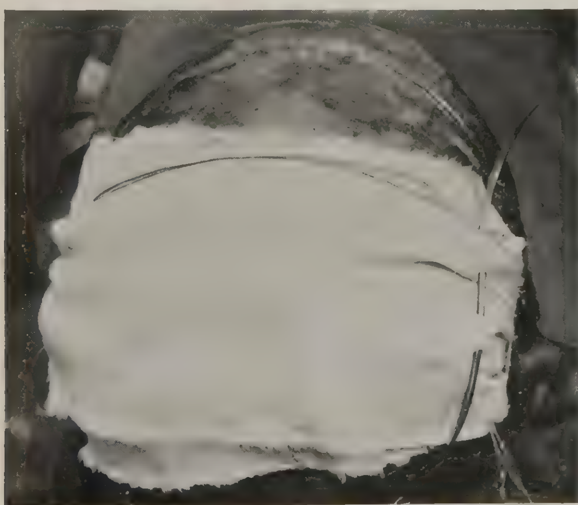

FIG. 303.—REPAIR OF SKULL. (B.)

The brain is replaced, the wedge of skull fitted on, and the ends of the bandage are firmly folded over the top and fastened by sewing, as shown, or they may be tied if there is plenty of hair.

the ears, and one in the frontal bone and one in the occipital bone. This will tend to prevent the piece of bone from slipping to either side.

To further assist in this fixation the cuts may be made to slant instead of being at right angles to the surface.

A number of methods have been proposed for holding the skull cap in place. The surest way is to place considerable supports of plaster of Paris, so that they extend well above the base and edges of the cuts. This is the simplest way where the skull is crushed, and with a little skill in building up layers while the parts are being replaced will enable one to secure excellent results.

When the brain is to be replaced in the skull there will be practically no spare space for this, so that one must choose between good repair of the surface, with some of the tissue placed elsewhere, and poor repair, with all the tissues in place. I find the use of the muslin bandage is the best routine method.

Take a piece of unbleached muslin bandage, at least 3 inches wide. Insert the edges in extensions of the cuts made to open the skull. These edges should be somewhat crowded or packed in the saw cuts. Then the brain is replaced with the skull cap; the free ends of the bandages are drawn tight and folded over the top of the bone, and either tied in a firm knot or sewed, as shown in Fig. 303; avoid pins. Sewing the muscles, fascia, and periosteum may at times succeed, but it generally fails to hold the parts in place.

The use of drills to make holes through which wires are passed is possible at a morgue, but is not suited for house-to-house work. Where the brain is to be removed the use of substances to fill the space is seldom necessary, and such substances when used should be selected with as much care as if one was sure the head was to be reopened in the presence of friends or relatives of the dead person.

The body should be left in as good condition as possible, and at least as clean as it was before the examination.

If the pelvic organs were freely opened it is well to pack a towel or cloth pad between the legs. The head should be elevated so as to prevent settling of blood, which causes discoloration, and if the brain has been examined, to prevent as far as possible leaking from the cut. The cuts in the body should be covered by clean cloths or, at least, the best that the conditions afford. Unless left in charge of the undertaker the body should be fully covered and properly placed. The best covering is a clean sheet; heavy blankets are to be avoided. The windows should be opened and blinds or curtains drawn so as to darken the room. The use of disinfectants in all infected cases should be as free as possible. My own practice is to have a basin with formaldehyd solution in which I rinse my gloves and instruments, and then, wetting the towel, I go over the body, leaving the wet towel in place over the body incision.

In rotten cases any smell, even tobacco, which helps to cover the extremely offensive odors, is to be used. If possible, the undertaker should be on hand, prepared to apply his art in such cases, as every minute counts in decomposing bodies that have been freely opened.

Where it has been necessary to freely dissect a part, and during such

cutting to remove any considerable amount of tissue, the contour of the part should be restored as far as possible.

Pads may be made of cotton, of cloth, or even of folded paper, and at times the tissues from the cavities will serve very well; often a piece of fat omentum will make an excellent pad.

Where the sternum was cut away it may be desirable to pad the thorax in order to restore the contour, though the undertaker usually arranges a pad of paper over the outside when he dresses the body.

In repairing large wounds one should not put on a surgical dressing, but simply bind up the part so that the clothing can be put on the body, leaving to the undertaker the draping of head wounds after the main sutures have been made and simple coverings applied. Special care should be taken to avoid staining the hair, specially if it is gray or white. Care must also be taken to avoid leaving offensive refuse about the room. All fluids should be emptied and soiled cloths carefully collected; papers and refuse should be burned.

CONCLUSIONS

After the apparent work is over at a postmortem one finds that the real work is far from finished. To have made all arrangements, carefully studied the history, selected the appropriate plan, conducted the examination according to the art, made suitable notes, repaired the body, is surely something of a task in a difficult case, but even after a correct cause of death has been given there often remains the major portion of the task. Nor does this consist in the rather simple routine work of cutting histologic sections, making cultures, or even testing for poisons, though these may cause considerable delay. There remains that immensely important process of drawing right conclusions, without which all that has been done or observed or surmised before are but elementary proceedings.

To have found a ruptured aneurysm, a pneumonia, a perforating ulcer, or any one or more of the thousands of possible findings may satisfy the routine worker, but they do not and cannot satisfy the intelligent mind of the real earnest student of the human body. Something larger still lies ahead that will tax to the utmost every bit of knowledge and intellect he has, and still he will have an unsatisfied desire for better insight.

When the thoughtful mind really takes up the problems of a case in the seclusion and quiet of his study, and begins to review each of the findings and to compare the values, part by part, and to readjust his estimates of the relations of conditions, then there is an opportunity that is worthy of the best intelligence the human mind is capable of exerting in any scientific endeavor. Let the operator sleep on the problem at least once, so that he may come to his task with a mind that is calm and free from the intensity of the period of observation, and when the first impressions are no longer dominant.

It need hardly be stated that much will remain unsolved even under the best possible conditions, but this habit of maintaining prolonged periods of careful after-thinking will very soon begin to yield those clearer conceptions of the problems that give a new and worthy impulse to future work, which will be of the greatest practical value, and without which no real progress can be hoped for. Of course, such methods will very quickly tend to separate one from the thoughtless follower of routine and those who talk glibly in stupid formulæ.

During this reconsideration of a real case the problems of biology, of physiology, and of pathology will present themselves in such a way that an overpowering sense of ignorance will be at times oppressive, and books will be wanted in which one can find help from master minds to enlarge and correct our knowledge and understanding.

Personal contact with such minds is of more value than books, but

there are few places where it is possible to reach any large number of such minds; however, there is generally some one with whom high-grade discussions can be cultivated. There will still remain the need of many books.

How often both books and persons will fail us is too well known to all earnest workers, but the greatest difficulty for those not yet well advanced in the work will be to be able to discriminate between the glibness of ignorance and the clearness of real wisdom and understanding. To turn from some highly rated work or authority with the sadness of utter disappointment is and must be a matter of almost daily occurrence, but to be sure not to turn from crude or even offensive wisdom to accept plausible error is the test of real patience.

To take up a revised edition of a really valuable work to find the changes made by a smaller mind than the original author is disheartening, but far from rare.

To find the errors of some old author quoted, copied, or rewritten through a score of works evidently written with unwarranted assurance is painfully common.

To seek for a clear discussion of the principles involved, and to find only threadbare repetitions of obvious error, is in a measure relieved by some accidental finding of genuine thought and insight in some neglected corner of the literature.

All these things go to make up the sorrows and joys of the scholar in any worthy branch of study, but, unfortunately, our branch has but few real scholars, and the literature is not only scanty, but its quality is terribly bad. At the risk of invading other fields and of exhausting the patience of the superficial I have introduced many topics that I would gladly have passed by with a reference, but because such could not be given, and because the theme was too important to be overlooked after the fashion of others, I have discussed the principles and at times some of the details rather fully.

While attempting to present many subjects clearly, certain references came to my mind, but it seemed best to collect these into a list of useful books in which the topics would be found carefully considered, so that the books in that list may supplement what is here presented, as this work in a way supplements those presentations. Finding that the works which present chiefly extracts from the various literature are but expanded bibliographies, and that they are to me singularly unsatisfying for reference, the scrap-book method has been purposely avoided.

The problems presented by each organ, both for that organ and for its relations, have been very frequently hinted at. The limits of time and space, as well as a not infrequent limitation of modern knowledge of the subject, have prevented the full discussion of those problems, but such problems are what make postmortems entrancingly interesting as well as of the utmost importance to all the other medical arts and sciences. There is no branch of biologic or medical science which cannot greatly profit by the results both of observation and thought of the work done at the postmortem and in the study afterward.

USEFUL BOOKS

PERHAPS the most dreary part of postmortem work is the search for information in the literature. To sit down before the Index Medicus and the Catalogue of the Surgeon General's Library and attempt from these masses of bibliography to select a few score of references that are likely to yield what you want, only to find quantities of information about other matters and almost nothing about the matter you are looking up, gets to be more than discouraging.

During the preparation of this book I have consulted every work less than a hundred years old on anatomy, pathology, bacteriology, postmortems, legal medicine, and scores of works on the clinical branches of medicine in the great library of the Philadelphia College of Physicians; from this enormous mass I have selected a few works in English which I believe will be of value to those who wish to find quickly the essentials of the problems they meet at the postmortem. In making this list I have thought it might be helpful to include certain notes from my cards on the bibliography as to the special value of and peculiar information contained in such books, and have departed from the usual method of making almost valueless lists of titles; such lists can be found elsewhere if any one wants them.

The list does not contain many books which I have found valuable, but only such as I have found that contain much useful information.

I make no other excuse for not naming the works written in other languages than that this list is not intended for the advanced scholar, for whom it will have limited value, but for the practitioner of the art of making postmortems.

The authors mentioned have, in large degree, digested the foreign literature, so that this disregard of that literature is more apparent than real.

On the art of making postmortems there is only one great work not already translated, that of Letulle, and the less said of most of the others the better.

Why the literature on this art should be on such a low plane must remain as a matter of wonder for future generations.

I have been led to include this list of books largely because of numerous letters asking for just such information.

Anatomy.

Gray. Anatomy.

This work is so solid, yet clear, that it will long rank as a reference work for all except experts. The early plates are far freer from artists' errors than the attempts of later works.

Deaver. Surgical Anatomy, 3 vols.

On the whole, I have found this to be the most useful single work on anatomy. The plates are not only not offensive, but they show that a great practical anatomist has controlled the impulses of the artist.

Piersol. Human Anatomy.

Generally good, but specially so in embryology, histology, and the nervous system.

Ranney. The Applied Anatomy of the Nervous System.

While perhaps not strictly modern, it presents a view of the subject too seldom grasped, but of immense value—that of the nervous system as a working mechanism.

Bacteriology.

McFarland. Text-book Upon the Pathogenic Bacteria.

This I find the best single work because the author has a comprehension of pathology far beyond the dreams of the ordinary bacteriologist. One may with profit and often must consult other works for special information.

Levy and Klemperer (translated by Eshner). Elements of Clinical Bacteriology.

Contains very useful analyses of the relation of lesions and bacteria.

Causes of Death and Classification of Diseases.

Manual of the International List of Causes of Death, printed by the U. S. Government.

This must be consulted by all persons engaged in issuing or recording or classifying causes of death.

The Bellevue Hospital Nomenclature of Diseases and Conditions.

This is one of the most thorough indices of diseases to be found anywhere.

Diagnosis.

Musser. Practical Treatise on Medical Diagnosis.

This is the most valuable single compendium, and presents a very full list of topics. Specially suggestive are the chapters on data obtained by observation.

Sahli. (American translation.)

A valuable and fairly complete résumé.

Dictionaries, Etc.

Those of Cattell and Dorland give concise information, but there is a quality about the work of Dunglison's Dictionary of Medical Science that makes it extremely valuable, specially for the older meanings and the derivations of words.

Reference Handbook of the Medical Sciences.

Contains many valuable articles which not only serve the immediate needs of one who must have the desired information quickly, but often gives the opinion of recognized authorities briefly and in a way not equalled in their larger works.

CLINICAL SPECIALITIES

Eye, Ear, Nose, and Throat.

The works of de Schweinitz, Kyle, and Randall are modern and useful, and contain enough for all ordinary work, and have the advantage of being written by men who have devoted much time to anatomy and pathology.

Children.

Holt. The Diseases of Infancy and Childhood.

The most satisfactory single work, and is particularly valuable because of the special paragraphs on lesions and etiology.

Hirst. Obstetrics.

Clear, full, and eminently satisfactory on most points.

Medicine.

This field is so large, and personal fancy and training must play such an important part, that one cannot do more than call attention to the danger of following a single individual on all points, and, on the other hand, the greater danger of the elaborate systems where essays of widely different value are put side by side, some being good and some being inexpressibly bad, the selection generally being made for literary rather than intrinsic merit.

It is well at times to have Flint's Treatise on the Principles and Practice of Medicine within reach, for it contains real thoughts about observed conditions, a matter much neglected these days; and one can easily pass over what is not modern.

Nervous System.

Gowers. Manual of Diseases of the Nervous System.

Too valuable to be omitted from any list.

Mills' work is very useful.

Skin.

Duhring. Cutaneous Medicine.

While not complete, is the work of a master mind, and helps us to understand many problems.

Schamberg. Diseases of the Skin and Eruptive Fevers.

A most valuable aid, with fine illustrations.

Stelwagon. Diseases of the Skin.

Authoritative and extremely valuable for quick reference.

Van Harlingen. Handbook of Skin Diseases.

Concise, easily referred to, and, resting as it does on large experience, trained observation, sound scholarship, and a clear mind, is of special value.

Welch and Schamberg. Acute Contagious Diseases.

An extremely useful work on the common forms of epidemic diseases.

Surgery.

Da Costa. Modern Surgery.

Most valuable because the author has a real mind, which he has applied to the problems with gratifying results.

Gross. System of Surgery.

While this is an old work, the wisdom of the author is rare, and it can be read with profit.

Scudder. The Treatment of Fractures.

Contains much valuable material.

Women.

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